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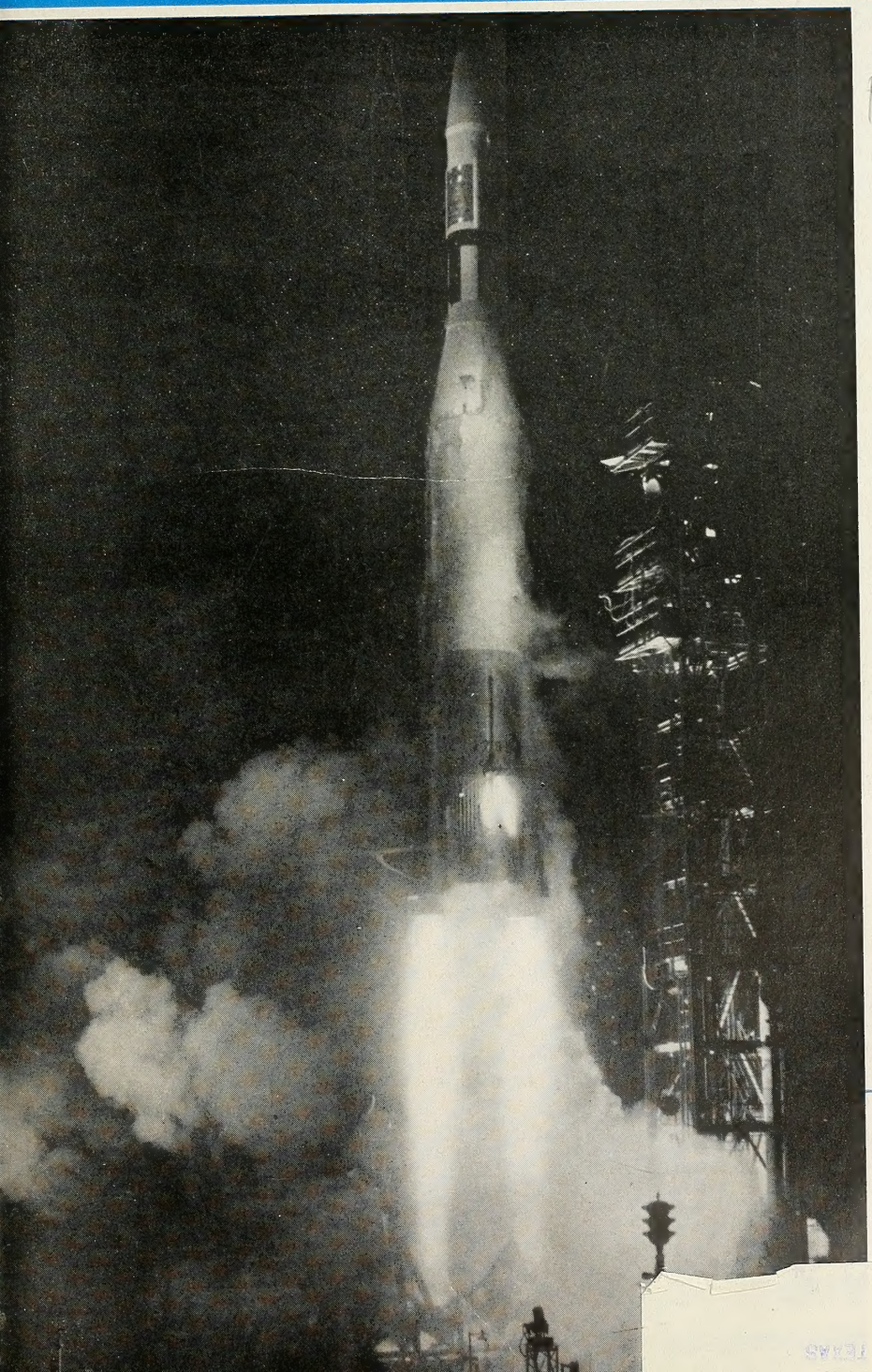
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SEPTEMBER 3, 1962

# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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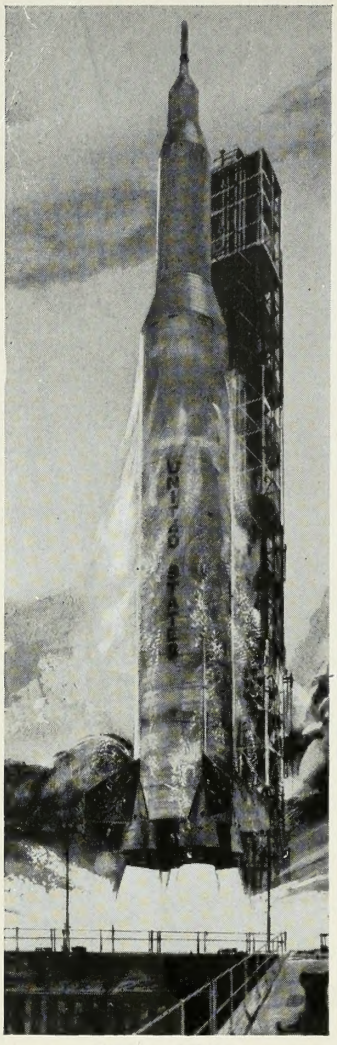
## Air Force Studying Space Trainer

- Report on Mariner II
- Gemini Vehicle Assembly Line
- Latest Edition Of M/R Astrolog

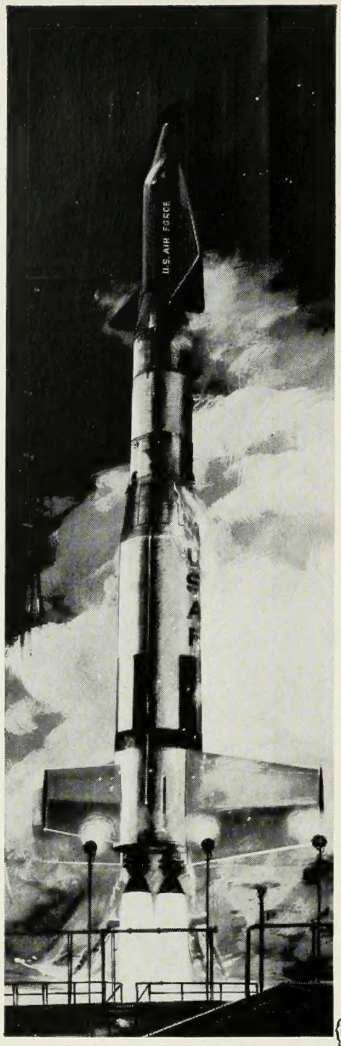
*Launch of Mariner II*

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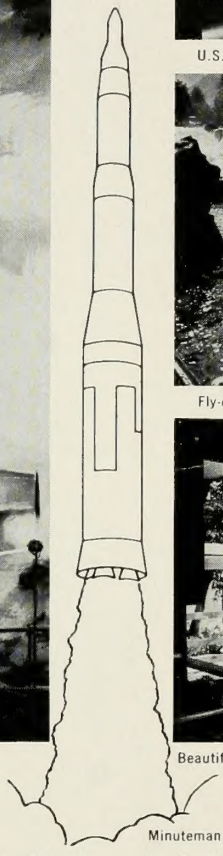
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 10 September 3, 1962

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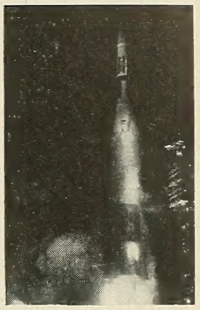
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## THE COVER

*Mariner II rises from Cape Canaveral aboard its Atlas-Agena vehicle on Aug. 27. If midcourse maneuver expected early this week is successful, spacecraft should fly within 10,000 miles of Venus in December.* *See p. 15.*

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# —letters—

## 'The Big Knife'

*To the Editor:*

You are to be commended for your Aug. 20 editorial ("The Big Knife"), especially your seven-point program for action. There is no question that No. 7 in your list, and the bulldog grip of a number of scientific advisers on the President and DOD is jeopardizing our very existence.

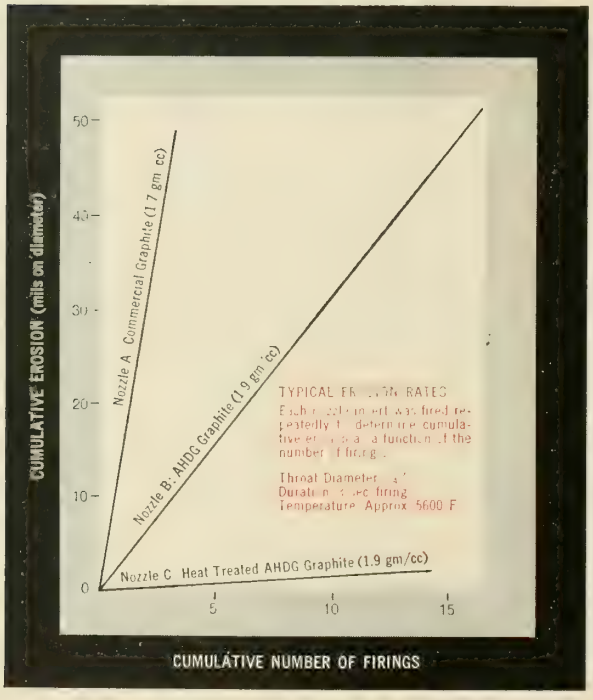
It appears that in the U.S. the scientists are calling the shots. A reputation in polymers or a prize in genetics qualifies many to pass judgment on operational, political, or strategic factors for which they have neither the background nor the inclination. The dark picture some paint of radiation dangers reminds us of the pessimists who howled about the sonic barrier and the thermal thicket—both of which we now call old hat. The engineers and strategists are hamstrung. Reports from the USSR or discussions with Soviet scientists indicate that engineers and strategists there have literally dragged their scientists screaming into the Space Age. The external shell of the Soviet space effort, for propaganda consumption, is peaceful scientific use. The core and direction of the effort is military-engineering-oriented — winged vehicles, big boosters—all with serious implications for us.

We also hear much today about public criticism of our space effort and its cost. The main difficulty here is that our NASA space program is being sold to the American public on a peaceful-uses, scientific basis. Historically, this approach has never met with much success. What is really vital is to redirect our space effort along the lines of military need—the area in which the true danger from the Soviet achievement exists. The recent Russian success is frightening in its military implications when placed in contrast to our deliberate but plodding approach along so-called scientific lines. It should be noted that we tried the same separation of scientific approach in *Vanguard,* which was an abysmal failure; only when we diverted military developments did we crack the orbital barrier. The contention of some that it's easy in Washington to get money for military machines is erroneous, at least in regard to military space machines.

Evidently we have learned very little from history. Practically all of the significant technological advances in aircraft, electronics, and similar fields have been made under the pressure of military and national survival needs. The fallout to science and engineering and consumer welfare has been tremendous—the 707 jetliner, the radar traffic control, the computer, the printed circuit in our TV sets, the transistor radio every teen-ager carries are cases in point. Now we are letting the tail wag the dog, running a space program under the suicidal guise of peaceful uses and hoping we'll get fallouts for military use.

In essence, we are really faced with

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a situation where it seems that only the appearance of a Billy Mitchell type of space proponent willing to sacrifice a significant career can jar some of the fuzzy thinking now being pursued at our highest administration levels. When the aircraft controversy was raging in the thirties, we had time to correct our mistakes; now we do not. With a country that can spend $7 billion per year on liquor, $4 billion on horse racing and $4 billion on tobacco, should we really be concerned over the bleeding hearts who bemoan the strain on our resources supposedly imposed by supporting a military space program upon which our national survival may depend?

The public must know that we have no significant military space program now, despite the euphoric pronouncements of DOD. We *must* have one. It may cost more than we are now spending.

GEORGE R. ARTHUR, PhD
Levittown, Pa.

*To the Editor:*

I have received every issue of MISSILES AND ROCKETS since its inception and, where time permitted, read all or parts of each issue. There have been times when I have disagreed with your editorial and reporting policies but have made no comment.

However, the editorial entitled "The Big Knife" compels me to shout a loud "Hurrah" for you. I am behind you 100 per cent.

After having worked a good number of years for DOD in the missile field, I am now working under NASA in the space exploration "game." I find little comfort in the statements made by top NASA officials that our game is going well and that we'll soon be ahead (or are already ahead, depending on which day's newspaper one reads). Can their "comforting" statements comfort anyone who merely looks at the scoreboard? Can their statements comfort us who work for NASA, or the general public, that our team captains are really as bright as they should be?

Name Withheld on Request

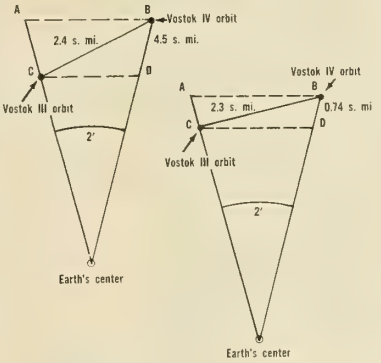
## Vostoks III & IV

*To the Editor:*

I would like to add some useful information to the continuing debate that has arisen as a result of the Russian demonstration of guidance, control and multiple launching capability in the prolonged flights of Cosmonauts Nikolayev and Popovich. Because of the (relatively) low perigees, the orbit parameters for *Vostok III* and *IV* changed rather rapidly; most calculations made are necessarily somewhat inexact. Nevertheless, for the present commentary such variations are trivial and may be neglected. Consider the following orbital parameter values published in *Izvestia* and *Pravda* of Aug. 12 and 13:

| | *Vostok III* | *Vostok IV* |
|---|---|---|
| Orbital Period | 88.2 min. | 88.3 min. |
| Orbit Plane Inclination | 64° 59′ | 64° 57′ |
| Apogee | 141.42 s. mi. | 145.9 s. mi. |
| Perigee | 109.8 s. mi. | 110.54 s. mi. |

A plane (more or less) normal to the *Vostoks'* velocity vectors, cutting both orbit planes and passing through the Earth's center yields the diagrams in the accompanying figure. This indicates the geometric relationship between the spacecraft during their orbital sojourn. As can be seen in the figure, the volume that contained both spacecraft had a varying (approximately) trapezoidal cross-section defined by points ABCD. At two points, the nodes of these orbital planes, the horizontal dimension (e.g., AB and CD) go to zero, leaving only an altitude variation to consider.




These particular points should be noted:

A. The maximum altitude difference between the two spacecraft occurred at apogee; this was 4.5 statute miles.

B. The minimum altitude separation was at perigee; this was 0.74 statute miles.

C. The angular separation of the orbits was 2 minutes of arc, resulting in a maximum distance between the spacecraft of 2.4 statute miles at apogee and a minimum distance of 2.3 statute miles at perigee.

Consequently, it can be seen that the slot that the *Vostoks* traveled in was never more than 2.4 miles wide and never more than 4.5 miles in height. This indicates a high capability for accomplishing the desirable procedure of rendezvous. Moreover, since the separation distance along the orbital path, noted early in the group flight, during the sixth orbit, was something less than 75 miles, it is reasonable to assume that a rendezvous and docking procedure could have been carried out with relative ease (and, of course, may have actually taken place).

The parenthetic remark is strengthened if one notes that the separation rate of the *Vostoks,* during the sixth orbit sighting, was about 50 miles per orbit. At this rate the two *Vostoks* should have been in the positions noted in the figure with *no separation along the orbital track* (e.g., somewhere between apogee and perigee separated only by a small altitude differential and a small horizontal distance) at about the interval midway between the fourth and fifth orbits. Thus the spacecraft either changed positions during this interval or they were quite close (docked?) and then commenced separation, using an impulse to place *Vostok III* in the lead for the remainder of the flight.

SAUNDERS B. KRAMER
Senior Member, American Astronautical Society
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# The Countdown

## WASHINGTON

### AF Getting New Agenas First

NASA will not begin to use the standardized Lockheed *Agena D* upper stage until late 1963 or early 1964. This means Air Force will get first crack at the new vehicles now coming off the assembly line. NASA, meanwhile, will use the remaining *Agena B's*. *Agena D* already has been test-flown (M/R, Aug. 20, p. 10).

### Mercury Is Slipping Again

Project *Mercury's MA-8* shot is running into the same slippage that plagued its predecessors. Originally set for the second week in September, technical problems already have pushed the launch back to Sept. 25. The possibility of further slippage due to the new radiation belt (M/R, Aug. 27, p. 13) still has not been excluded.

### Aerospace Plane Committee Completes Work

The special *ad hoc* committee drawing up a joint research program for *Aerospace Plane* now has completed its work. Approval by top NASA and Department of Defense officials appears months away, however. Much will depend on how fast the Air Force can obtain DOD approval for funding. Although NASA has a long-term requirement for a recoverable booster, the space agency is too busy with *Apollo* and future manned programs to take much of an immediate interest in *ASP*.

### DCA Looking for ComSat Manager

Defense Communications Agency—recently given responsibility for interface problems of the re-oriented DOD communications satellite programs—is negotiating with a major aerospace firm to act as technical advisor and manager on the programs. Negotiations are snagged on the fact that the company might be excluded from bidding on hardware for any defense communications projects.

### Anti-Satellite Zeus Still under Study

Department of Defense confirms that it still is studying possible use of *Nike-Zeus* as an anti-satellite weapon but refuses to comment further on the prospect. Project *Hi-Hoe* (M/R, Aug. 20, p. 16) also has anti-satellite implications.

### No New Boosters on Vostoks

Department of Defense study of the orbits and other available data from the twin *Vostok* space flights has lead to the conclusion that no new boosters were used to launch them. Meanwhile, industry firms connected with the military tracking network confirm that there are no data to support a conclusion that the two Soviet craft accomplished rendezvous and docking.

### Apollo Fashion Note

NASA is developing a water-filled jacket to help provide radiation protection for *Apollo* astronauts. The torso jacket, covering the body from neck to pelvis, will be inflated with water to a thickness of about three inches.

### Mercury Radiation Data Classified

Radiation data from Project *Mercury* flights will remain classified to keep the information from the Russians, according to a NASA spokesman. He says NASA also will hold a tight rein on *Apollo* data for two reasons: "We don't want to talk about something that might change, and we don't want to help the Russians any more than necessary. Let them work for it themselves." Problem: how to square this attitude with the freedom of information provisions in the NASA enabling act.

### Reserves to Get ENTAC Missiles

Some $5 million worth of French-made *ENTAC* antitank missiles are scheduled for delivery to high-priority Reserve and National Guard units during Fiscal '63. Some consideration was given to equipping the units with the older *SS-11*, but this has been ruled out.

## INDUSTRY

### NASA Studies GE Eligibility

Question of whether General Electric is eligible for a Lunar Logistics Vehicle contract despite its Project *Apollo* systems integration contract (M/R, Aug. 27, p. 10) still is under discussion by top NASA and GE officials. This could be an important test case. Industry is concerned about a recommendation in the Bell report on government R&D contracting that firms giving technical advice to an agency be excluded from bidding on hardware contracts. This is being interpreted by some DOD officials to be an across-the-board ruling covering all agencies. This could exclude a firm with a NASA ComSat integration contract from bidding on hardware in a DOD ComSat program.

### Marquardt to Get Plasma Contract

NASA is negotiating a contract with Marquardt Corp. for a program of applied research and experimental testing to establish and demonstrate feasibility of plasma propulsion. Eventual goal is achievement of high acceleration for both manned and unmanned spacecraft on long interplanetary missions.

### Minuteman Troubles Traced

Two most recent *Minuteman* launch failures had nothing to do with the fact that they were Wing II vehicles. Cause of one has been traced to computer trouble and the other to a first-stage malfunction. New second stage got a clean bill of health.

## INTERNATIONAL

### First Japanese Missile Launch Due

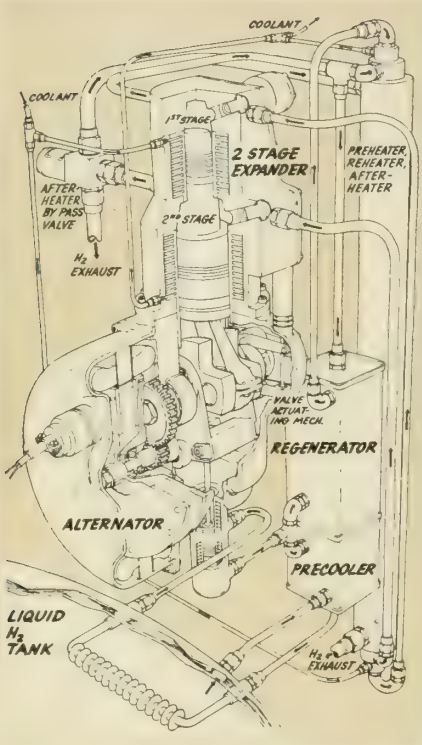
First launching of Japanese-made guided missiles is scheduled on the newly-completed Niijima Island missile range south of Tokyo late in September. Missiles to be fired are a *TRAM 2* ground-to-air weapon and a *TAAM* air-to-air rocket similar to the U.S. *Sidewinder*.

### Italy Planning Equatorial Launch

Italy plans to put the first equatorial-launch satellite into orbit in about three years. Launch is to be from a Texas Tower-type platform in the Indian Ocean. Satellite, weighing 165 lbs., will be designed to measure local density in the upper atmospheric layer at altitudes of 200-300 km. Goddard Space Flight Center will assist in the training of Italian scientists on the project.

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# SPACE POWER SYSTEM UTILIZES UNIQUE LIQUID HYDROGEN PUMP —REQUIRES NO RADIATORS




One space power system now in the advanced test phase at Sundstrand Aviation—Denver avoids the life-limiting possibility of radiator meteoroid penetration by utilizing all vehicle waste heat in the thermodynamic cycle. Even the body heat of the astronauts is used in the CRYHOCYCLE-R, a reciprocating expansion engine which uses such normally wasted heat to expand liquid hydrogen in its cylinders. A generator, connected through a small gearbox, provides up to 10kw of electrical current to power instrumentation, lights and air conditioning in the vehicle. Heating the working fluid in this unique fashion, both between stages and in the cylinder, significantly reduces the specific propellant consumption, provides nearly automatic thermal control, and requires no radiators. This concept is feasible with a Sundstrand-designed liquid hydrogen pump which takes low pressure fluid (20 to 30 psi) and raises it to a pressure of 2250 psi. Evaporation of the hydrogen to gaseous form produces useful cooling. High inlet pressure at the first stage makes possible extremely low fuel consumption, another benefit inherent in the pump design. The pump is additionally unique in its ability to operate as a compressor of gaseous hydrogen. This gives a first stage recirculation feature, lowering specific fuel consumption still further. The CRYHOCYCLE-R occupies little space, which together with the absence of radiators, makes it ideal for lunar operations and re-entry vehicles. Because it operates on cryogenic propellant (and can utilize boil-off) it has many advantages for rendezvous application. For an over-all picture of Sundstrand's broad experience in cryogenic, storable, and solar power systems or for help in your special pump problems, send a request to our sales department on your business stationery. If you would like to work on the Sundstrand engineering team, finding practical solutions to challenging space problems, write to: Personnel Director,

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### Shots of the Week

*Mariner II,* NASA's second attempt to send a spacecraft to within 10,000 miles of the planet Venus, was successfully launched from Cape Canaveral Aug. 27 by an *Atlas-Agena* (see p. 15). An error of some 250,000 miles was discovered in the 447-lb. spacecraft's trajectory after injection. However, this error can be eliminated, JPL scientists say, by commanding a midcourse maneuver. Set for this week, the maneuver is expected to add a velocity increment of about 80 mph to *Mariner* and thereby bring it back to its trajectory.

• The Air Force attempted to orbit two secret satellites. One was sent up from Pt. Arguello, Calif., on Aug. 23 aboard a *Blue Scout;* the second from Vandenberg AFB, Calif., on Aug. 28 on an *Atlas-Agena.* No further information on either shot was released.

• The Army successfully launched a *Nike-Zeus* from White Sands Missile Range, N.M., on Aug. 28. Part of the continuing development program for the antimissile missile, the test reportedly accomplished all of its objectives.

The success followed the destruction in flight of a *Nike-Zeus* launched from Pt. Mugu, Calif., Aug. 24. An automatic device "set to extremely close limits to ensure flight safety" activated and terminated the test when the third stage malfunctioned, an Army announcement said.

• A *Polaris* missile carrying components of the advanced, 2500-mile *A3* model was launched from a land pad at Cape Canaveral Aug. 27. Reportedly successful, the *Polaris* travelled 1400 miles down the Atlantic Range.

### Variable-Thrust Engine Fired

A long-duration, variable-thrust liquid engine with an ablative thrust chamber has been test-fired by Aerojet-General's Space Propulsion Division. A variable area injector handled the throttling providing a range from 0 to 2200 lbs. Two restarts were accomplished using nitrogen tetroxide and Aerozine/50. The test firing included a pre-selected thrust-level sequence demonstrating response characteristics and repeated manual operation.

### Douglas Plans Space Center

Construction will begin within the next few weeks on Douglas Air-

craft Co.'s privately financed Space Systems Center near Huntington Beach, Calif. Located on a 245-acre site, the Center is initially being built to meet the requirements of NASA's *Saturn* program.

However, the Space Center eventually is planned to provide Douglas with an integrated network of research and development laboratories keyed to future manned space flight.

The *S-IVB*—an upper-stage vehicle for the *Saturn C-1B* and *Advanced Saturn*—will be designed, assembled and tested at the Center.

## Senate Restores NASA Cuts

The Senate Appropriations Committee has restored $60 million of the $100 million cut from the NASA Appropriation bill by the House earlier this year. Restored was $40 million in research, development and operations funds and $20 million in construction money.

At the same time, the Committee took notice that unexpected and unprogramed expenditures may be required due to changes in the manned lunar landing program from Earth-orbit to lunar-orbit rendezvous. In this event, the Committee indicated that a supplemental appropriation could be considered early next year.

## AEC Nominees Confirmed

James T. Ramey, former staff director of the Joint Committee on Atomic Energy, and John G. Palfrey, former Dean of Columbia University's undergraduate college, were confirmed by the Senate on Aug. 24 as members of the Atomic Energy Commission.

## New X-Ray Source Discovered

An *Aerobee* rocket fired June 18 to an altitude of 150 miles above the White Sands (N.M.) Missile Range accidentally discovered a new source of X-rays in space.

Carrying Geiger-counters as part of an Air Force-sponsored lunar research program, the rocket recorded the X-rays—apparently being emitted from the vicinity of the constellation Scorpius—and radioed the data to ground stations. Previously, the Sun had been the only known source of X-ray emissions; the rocket had been intended to measure the effects on the moon of X-rays from the Sun.

Dr. Riccardo Giaconni, an Italian physicist working for the American Science and Engineering Co. of Cambridge, Mass., told the Third International Symposium on X-ray optics and X-ray Microanalysis, that "these results are of tremendous significance and may have a bearing on the study of communication of matter between galaxies."

Predicting that the discovery would lead to an extensive new line of research, Giaconni told the Symposium a second rocket would be launched at midnight Oct. 2 to gather further data. He also indicated that, since a rocket's useful lifetime was so short, NASA would be asked to launch a satellite so that a continuous check could be made on the X-ray source.

## DOD Blocks Industry Briefing

A written memorandum from Deputy Defense Secretary Roswell Gilpatric to Air Force Secretary Eugene Zuckert requesting that an industry briefing on AF advance planning "be revised or cancelled" caused considerable concern in Washington.

Although a Pentagon spokesman mantained that the briefing—an annual feature of the AF Ballistic Missile and Space Technology Symposium—was presented with "no significant changes," considerable material was in fact deleted as not reflecting DOD policy on military space. As a result, the presentation was completely ineffective, according to officials who attended the Symposium.

The Gilpatric memorandum also stated that DOD believes it is "inappropriate and unwise" to provide either Congress or industry with information on advanced AF planning until it is submitted either to himself or Defense Secretary McNamara.

Gilpatric also pointed out that DOD's Defense Industrial Advisory Committee has been established to provide "a forum for policy discussions with leaders of defense industry" including "discussions of DOD forward planning to the extent that it is deemed necessary."

## Security Directive Outlined

Dept. of Defense continued last week to resist Congressional efforts aimed at declassification of its so-called "space security" directive. MISSILES AND ROCKETS, however, was able to obtain a partial listing of restrictions imposed on the military services and industrial contractors by the directive.

The following guidance is given on preparation of advertisements, news releases, brochures, financial reports, technical papers, photographs, motion pictures and other information on military space programs:

- Project names and nicknames can no longer be used.
- Projects henceforth are to be referred to only by program number.
- No information can be released on missions and objectives of military space programs when such information is connected to specific launches or programs.
- Linking of any two of the three above items automatically creates a classified document.
- Booster names such as *Thor* and *Atlas* may be used and space vehicles such as *Agena* may be referred to by their general term.
- These restrictions are not to be considered as limiting public discussion of various space concepts such as orbital rendezvous, infrared detection and scientific research, providing such discussion is in generic terms and consistent with the foregoing.

## New WSEG Orders Issued

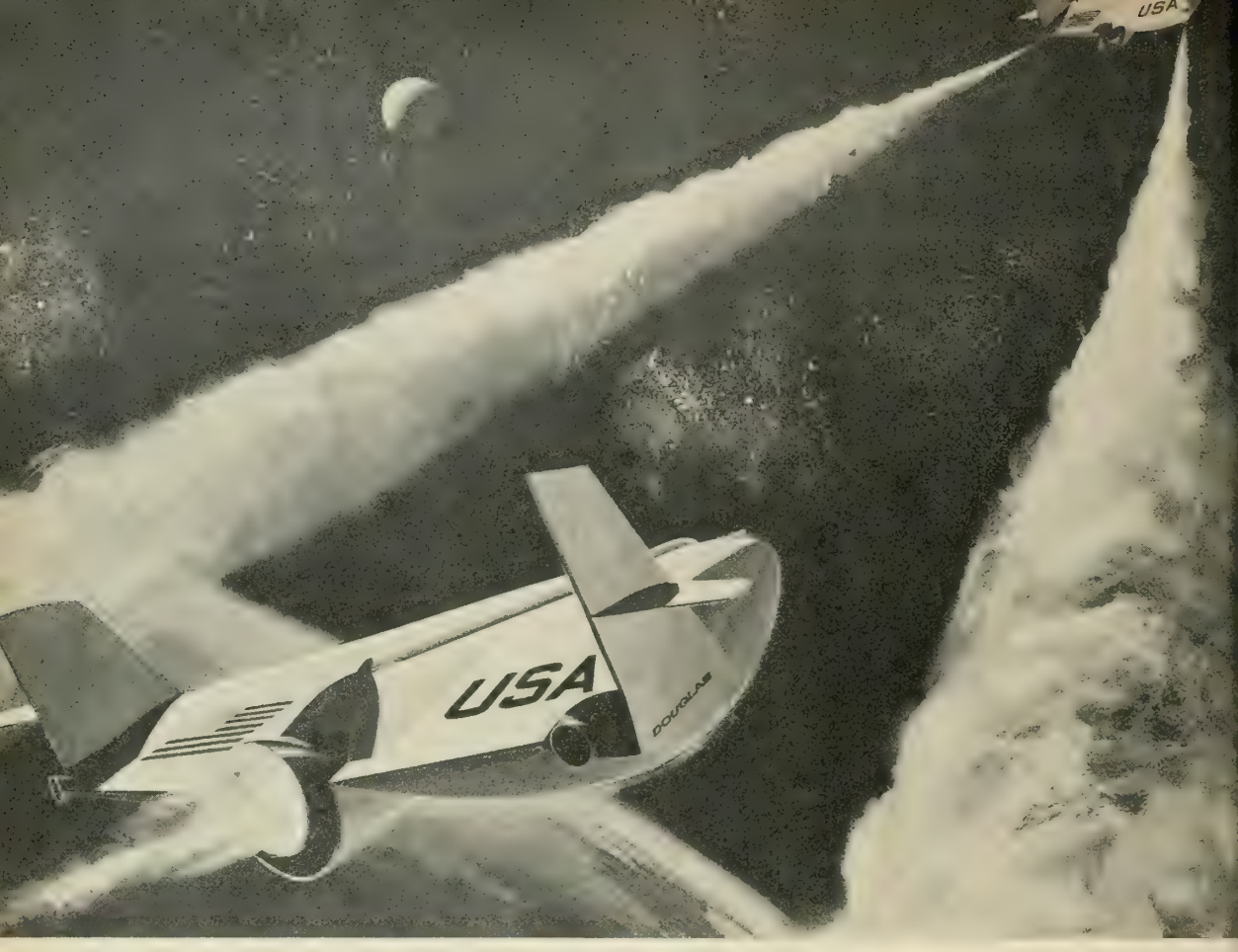
A new DOD directive outlining responsibilities of the Weapons System Evaluation Group was under fire last week for its apparent curtailment of the freedom of action the group formerly enjoyed.

The controversial document was prepared under supervision of Defense Research and Engineering chief Dr. Harold Brown.

Omitted from the new directive were two important phases of previous WSEG activities: responsibility for undertaking "such studies as the group itself may decide to initiate," and a stipulation that "service comments, as requested, on a completed report will be given the same distribution as the report."

Lt. Gen. William P. Ennis, retiring chief of WSEG, told a congressional committee that the new directive will result in a "further downgrading of the military."

Brown admitted he was fully aware of the objections of professional military officers to the directive, but had in effect chosen to ignore the complaints. Notable among those ignored was Gen. Lyman L. Lemnitzer, chairman of the Joint Chiefs of Staff.




*ASTRO—a manned reusable spacecraft concept developed by Douglas Aircraft.*

***An M/R Exclusive—***

# Air Force Studies Space Trainer

***Missile/space firms submit early proposals***
***In warm-up for Aerospace Plane competition***

INDUSTRY PROPOSALS for a space-flight trainer vehicle are now being studied by the Air Force Aerospace Research Pilot School, Edwards AFB, Calif., in anticipation of development funding of the vehicle in the Fiscal 1964 budget.

The school's procurement request is to be forwarded to the Pentagon within the next few months.

Design proposals make it apparent that industry, meanwhile, is looking beyond the training concept to take advantage of the opportunity as an early design exercise on *Aerospace Plane (ASP)*, adding to already increased activity in this field (M/R, Aug. 27, p. 12).

Latest in a series of proposals from major aerospace concerns were received at the school within the past month from North American Aviation and Douglas Aircraft Co. Other companies with proposals: Boeing, Chance Vought and Republic.

• **The proposals**—North American has submitted plans for an aerospace research pilot trainer derived from the *X-15*. Called the *STX-15*, it would be the current NASA vehicle with some modifications: new support equipment to permit horizontal takeoff from a drop-off dolly or rocket-sled with rocket assist, and a vertical takeoff from a zero-launch erector in addition to the air-launch method.

*STX-15* could be programed to simulate the *X-20* in glide. Pentagon budget-watchers are expected to favor *STX-15* if an Air Force trainer is approved, since it offers a low-cost development effort. However, space school officials are said to favor a true spacecraft of

the type proposed by Douglas.

• **The ASTRO concept**—Douglas wants to make the *ASTRO* system—*Advanced Spacecraft Truck/Trainer/Transport Reusable Orbiter*—as flexible as possible. Consequently, the vehicles developed under the program are designed to be useful for all missions conceivable for an *Aerospace Plane:* defense bombardment, reconnaissance, satellite inspection, satellite interception *(SAINT II),* satellite logistic support, recoverable space laboratory, astronaut training, maintenance, rescue and supply.

Douglas says that the idea behind the concept is to put man into space operationally within the 1964-70 period. An orbiting system is proposed. It would draw almost entirely on today's technology.

In evaluating the classes of vehicles that might satisfy the *ASTRO* mission, the company seriously considered two possible classes: the very large craft carrying 250,000 lbs. or more payload, with infrequent flight schedules; a smaller system carrying under 50,000 lbs., with frequent flight schedules.

Douglas decided that the smaller system could be more easily designed to be recoverable and reusable—needed qualities for an economical system. It would moreover be an easier system to develop. Thus the company adopted the idea of designing a relatively lightweight system able to carry a payload of 10 tons into a modest orbit of about 300 nautical miles. Chief characteristics will be the ability to maneuver both in orbit and in subsonic flight.

In view of this philosophy, Douglas engineers chose a lifting-body craft as the basis of the *ASTRO* design.

• **What it looks like**—The *ASTRO* system is described as a manned booster-spacecraft concept based upon combining aircraft aerodynamics with rocketry. It comprises two manned reusable delta-winged vehicles powered by available engine types. These vehicles are the system's building blocks.

The delta wings were derived from a subsonic airfoil modified to meet hypersonic, thermodynamic, and aerodynamic stability requirements. Even though the configuration favors the subsonic flying regime, the primary design factors were introduced by the low hypersonic heating environment. Through a proper combination of airfoil geometry and flight mechanics, the dynamic loading and aerodynamic heating on the vehicles are said to be kept as small as possible.

When the first vehicle is used alone, it takes off and lands horizontally.

When the two vehicles are used in tandem—the orbital configuration—the pair takes off vertically and separates. Each vehicle lands horizontally on skids and steerable nose gear.

Engines using liquid oxygen-hydrogen are to be used because of their high performance. Types mentioned by Douglas: the RL-10, J-2 and M-1, offering, as modules, thrust levels of 15,000 lbs., 200,000 lbs., and 1.2-1.5 million lbs., respectively.

• **Specifications** — The *ASTRO* spacecraft and booster are similarly designed, basic differences being the crew compartments and power levels.

The spacecraft—*A2*—is 65 ft. long and has a 44-ft. wing span. Piloted by a crew of two and ultimately able to carry 10 passengers, the vehicle is designed with one J-2 engine and two RL-10 engines gimballed. Internal tankage provides for 165,000 lbs. of propellant.

The booster—*B*—is a scaled-up version of the spacecraft. The capsule, however, is designed for a one-man crew; the powerplant comprises one M-1 and two J-2's. The craft is 95 ft. long and has a wing span of 61 ft. Internal tankage provides for 594,000 lbs. of propellant.

Both ships in tandem are 159 ft. long, slightly less than the length of a DC-8.

Flight separation of the spacecraft —*A2*—from the booster—*B*—occurs at zero-g so that little difficulty is anticipated.

• **Payload**—Vehicle *A2* is designed as a basic truck with on-board systems common to three selected missions: cameras for reconnaissance; inspection, kill and capture equipment for satellite surveillance; maintenance equipment involving modular spares, tether reels, and shuttle vehicles for repair, cargo transfer, and general service.

The shuttle vehicle could be a self-dependent system, manned, with propulsion and ecological systems on board.

The *A2* contains an abortable crew compartment, cargo compartment and fuel tanks. Because of abort jettisoning, the crew is located forward.

The cargo compartment located immediately aft of the crew compartment has a volume of 525 cu. ft. Although the payload is rated up to 20,000 lbs., a portion of the cargo probably should be assessed to orbital fuel required for maneuverability and ejection from orbit. Since the compartment size is fixed, it may be necessary to carry some cargo piggyback in detachable pods.

Certain payload, such as passengers and some equipment, will be contained in a pressurized compartment. Other payload may be stored in non-pressurized areas.

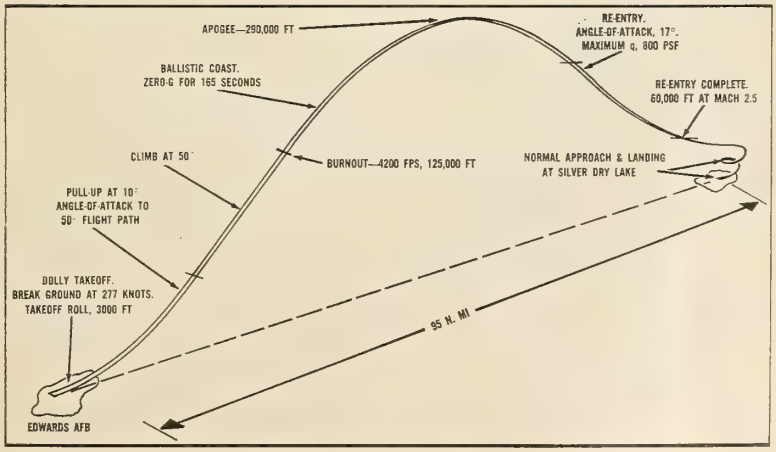
Since one of the missions of *ASTRO* is servicing manned satellites, maintenance personnel will be located in the cargo compartment. The crew separation, normally forward of this compartment, now moves aft of the passenger compartment so that the crew, as well as passengers, are provided with abort capabilities.

Since the payload weight of a given vehicle is affected by the launch site and azimuth, an optimum launch is from the equator with a launch azimuth of 90° (due east). Any displacement from these launch conditions will result in a payload degradation.

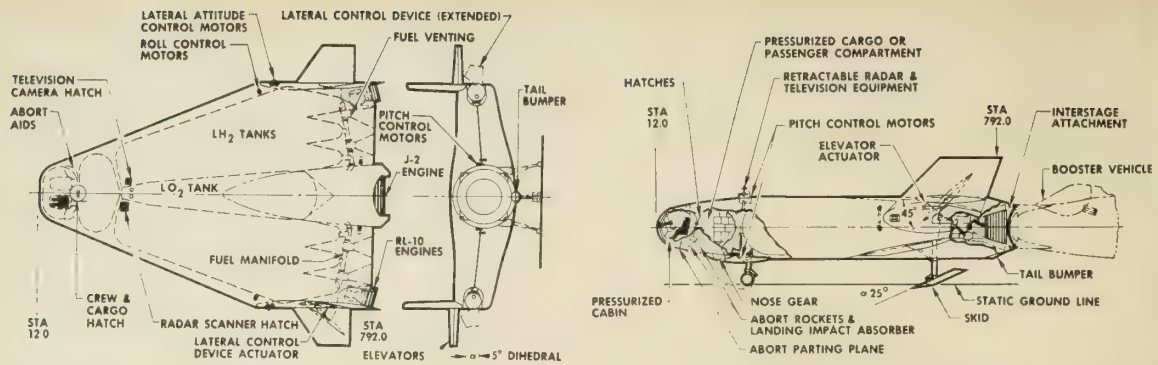
• **Development program** — A systematic checkout of vehicle R&D can be accomplished by a four-phase plan, according to Douglas:

In Phase I, *ASTRO* can take off either horizontally (using a powered sled) or vertically (using six *Zeus* sustainers). Piloted by two astronauts, the thick delta-winged craft is propelled by $LO_2/LH_2$ engines on non-orbital transcontinental or transoceanic missions. It is used to test the system, to train the pilots, and to transport up to 5000 lbs. of payload. The pilot lands the ship on its skids and nose gear. Abort capability is provided.

In Phase II, *ASTRO* takes off vertically in a two-stage tandem configuration, both stages being essentially the




*TYPICAL X-15 space-trainer mission with dolly take-off.*




*PLAN AND ELEVATION views of ASTRO A2 vehicle. Note booster vehicle attachment at aft end.*

same as the Phase I craft. The first stage, however, has two additional J-2 engines and an abort capsule for the pilot; the second stage carries both a pilot and co-pilot and is equipped with a cargo/passenger compartment. The second stage is designed to orbit at 300 nautical miles with a useful load of 2000 lbs. (part of which is propellant for rejection from orbit). Both stages are landed horizontally.

In Phase III, *ASTRO* is simply a larger version of the Phase II craft. The scaled-up first-stage booster is powered by one M-1 and two J-2 engines, and the second stage carries a 20,000-lb. payload to an orbit of 300 nautical miles. Ten passengers can be accommodated. Pilots bring both stages back for re-use. Payload includes propellant for rendezvous and ejection.

• **Putting USAF in space**—Acquisition of a space trainer would go far toward establishing an Air Force beachhead in manned space flight. Plans for the space pilot's school are calculated to give the Air Force a foot-in-the-door by establishing the school as the prime source of the nation's men best qualified to become NASA astronauts.

The school was sorely disappointed recently when it could not, at NASA's request, provide a pilot for *Gemini*. "We didn't have one," an officer said. "Our guys are getting too old."

Plans call for compressing the school's present 16-month course into 12 months, perhaps starting next February; accepting applications only from Air Force personnel (one Navy pilot is in the current class); changing school entrance requirements to enable recruitment of younger men; increasing the number of students from the present 8 to 64 by January, 1964; and improving simulator training, both ground and air-based, to cover all phases of space flight, including orbital rendezvous, re-entry, navigation and lunar landing. The school expects to have the most advanced simulator to date within two years. It will simulate everything but lunar landing.

"We want to train men who can be selected for NASA programs," a spokesman said. "If we had started this earlier, we could have had men picked for *Gemini*."

Hard plans call for combining the school's two courses—experimental test pilot course and aerospace course—into one package July 1, 1963. Since there is much duplication in the courses, the combined class can be graduated in one year. The experimental test pilot course started Aug. 27 will be the last one. After the classes are combined, graduates will be qualified as both test pilots and aerospace research pilots.

With the course starting Oct. 22, the school will try to drop student age level to 32-33 years. A present block to obtaining younger students is the 1500 hrs. flying time required, regardless of aircraft type experience. The school will seek approval to drop that requirement so it can select men with 800-1000 hrs. experience in high-performance aircraft "instead of waiting until candidates build up 1500 hrs., even in gooney birds, to qualify." ❖

## DOD May Develop Own Weather Satellite

DEPARTMENT OF DEFENSE is considering development of its own weather satellite system following disclosure that NASA's *Nimbus* is a year or more behind schedule.

Air Force Lt. Col. Leslie W. Cowan told the House Space Committee last week that "military operational use of *Nimbus* will now be delayed until 1965 or later."

Cowan said that if *Nimbus* can not fulfill the DOD need for weather data, consideration should be given to building a military system.

Meanwhile, NASA officials revealed that more *Tiros* satellites than the three currently planned will be developed to fill the gap caused by the *Nimbus* delay.

A space agency spokesman admitted that the first launch of *Nimbus*—now slated for the second quarter of 1963—has slipped one year from its original schedule.

He also said the program is being reviewed in NASA and further slippage is possible. The current difficulty stems from development problems in the satellite's cameras, and its control and power systems.

The NASA spokesman pointed out that the space agency earlier told Congress it will continue to launch first-generation *Tiros* satellites until *Nimbus* is ready, with one *Tiros* always in orbit.

Dr. Fred S. Singer, director of the Weather Bureau's National Weather Satellite Center, however, wants two *Tiros* satellites kept in orbit at all times until *Nimbus* is ready. He said he will present his proposal to an interagency user group for approval.

Cowan charged that a key element of the approved *Nimbus* development plan, namely a European ground station, is still under study. He also said that no action has been taken on development of a direct readout system which is urgently required by the military users of the system.

*Nimbus* is a far more complicated satellite than the current *Tiros*, which has chalked up five out of five successful launches. *Nimbus* is scheduled to travel in a polar orbit which will permit greater coverage of the earth's weather and it is being designed so that its instruments and cameras always point at Earth.

*Tiros* is limited in both the amount of its coverage and the period of time its cameras are earth-oriented.

# Mariner Success Hinges on Maneuver

## *Highly successful launch followed by doubts due to roll; precise midcourse motor awaits signals from three stations*

**by Hal Taylor**

THE SUCCESS of *Mariner II's* 180-million-mile trip to Venus hinges on a midcourse guidance correction scheduled for early this week. NASA scientists last week tentatively announced that the midcourse maneuver would be attempted on Sept. 2 or 3.

*Mariner II* was launched at 1:53 a.m. EST on Aug. 27. If it is successful, the U.S. will have taken a major step in its program of future manned interplanetary flight—and perhaps answered part of the age-old question of the possibility of life on distant planets.

It will also mean that this country has chalked up a major victory over Russia in the space race. The Soviet Union in 1961 dispatched a spacecraft toward Venus, but radio contact was lost after 18 days. The first U.S. attempt, *Mariner I,* failed on July 22 when an erroneous guidance signal sent its *Atlas D* launch vehicle off course (M/R, July 30, p. 18).

At 11:13 a.m. EST Aug. 29, *Mariner II* was 447,897 miles from Earth, traveling at a speed of 7117 miles per hour. Data were already being received from four of its six experiments, but there was still no indication as to its quality. Two other experiments—to study Venus's temperature and atmosphere—will be turned on when the spacecraft comes within 10,000 miles of the planet.

If all goes well, this completion of *Mariner's* 109-day, 180,200,000-mile trip will come during the second week of December.

The 447-lb. spacecraft measures 5 ft. in diameter and is 9 ft. 11 inches long. In the cruise position, with its solar panels extended it is 11 ft. 11 inches high with a span of 16 ft. 6 inches.

• **Spirits rise**—As scientists at the Jet Propulsion Laboratory prepared the computations for the midcourse guidance maneuver, they declared the instrument-laden spacecraft was performing "remarkably well." They said that they were confident it would fulfill its mission.

This was a far cry from the pessimism prevalent shortly after launch.

Then, scientists announced that heavy rolling of the launch vehicle had pushed the spacecraft some 600,000 miles off its intersection course with Venus's orbit.

It was later reported, however, that "normal dispersion" in the launch vehicle had pushed the spacecraft only 250,000 miles off course. This, the scientists said, could be corrected by the midcourse maneuver.

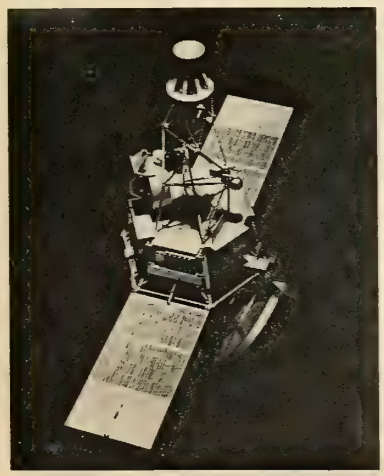
Correction of the deviation, they said, could be effected by adding only 80 mph to *Mariner's* velocity—well within the midcourse motors' 120-mph acceleration capability.

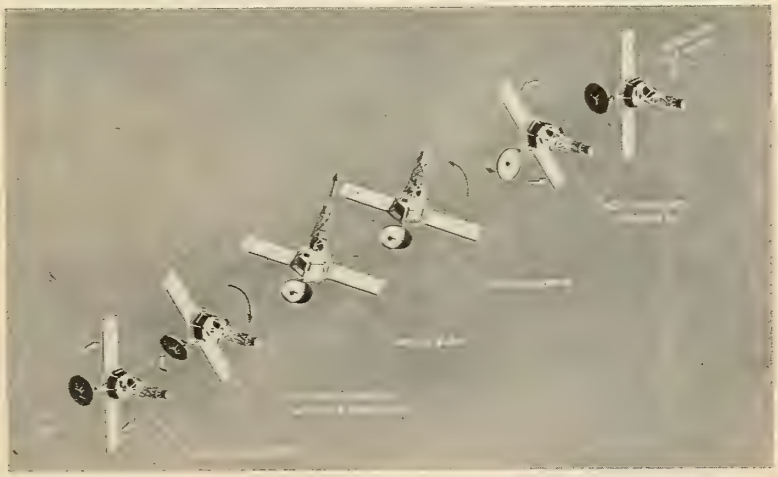
• **Command setup**—Control of the midcourse correction will be handled by the Goldstone, Calif., Deep Space Instrumentation Tracking Station. Goldstone, along with stations in Johannesburg, South Africa, and Woomera, Australia, forms a three-station network for *Mariner* and other interplanetary programs.

The liquid-monopropellant midcourse motor weighs 37.3 lbs. with its hydrazine fuel and the nitrogen pressure gas systems.

It is so precise that it can burn in bursts of as little as seven-tenths of a foot per second or as much as 187 ft. per sec. It has a thrust of 50 lbs. for a maximum of 57 seconds.

The first command from Goldstone will give the direction and amount of





*MARINER II spacecraft is shown (at left) in unfolded position. Four of six experiments aboard are already in operation. Remaining two will begin functioning when craft flies by Venus. Drawing at right shows vital midcourse guidance maneuver.*

roll required, the second will give the direction and amount of pitch needed, and the third will give the amount of velocity increment needed. These data are stored in the command system until Goldstone transmits a "go" command.

Commands preprogramed for the midcourse sequence initiate the following: The Earth sensor, mounted on the dish-shaped antenna, is turned off. The hinge-mounted directional antenna itself is moved out of the path of the midcourse motor's exhaust. During the maneuver, the gyros (turned on an hour earlier to warm up) will inform the attitude control subsystem of the rate of pitch and roll as they occur for reference against the orders from Earth. A pulse-balanced accelerometer will be turned on to provide acceleration rates during motor burn. Each pulse from the accelerometer represents a velocity increment of 0.03 meters per second.

The roll maneuver requires a maximum of 12 minutes of time, including two minutes of settling time, and the pitch maneuver requires a maximum of 22 minutes. When these are completed, the midcourse motor is turned on and burns for the commanded time. As the attitude-control gas jets are not powerful enough to maintain the stability of the spacecraft during the propulsion phase of the midcourse maneuver, movable jet vanes extending into the exhaust of the midcourse motor control the attitude of the spacecraft in this period.

The jet vanes are controlled by an autopilot subsystem in the attitude control system that functions only during the midcourse maneuver. The autopilot accepts information from the gyros to direct the thrust of the motor through the spacecraft's center of gravity, stabilizing the craft.

Once the guidance correction is completed, the spacecraft will continue its flight until planet encounter. Then, the last two experiments will be turned on in an attempt to answer questions about Venus's environment.

• **Solving mysteries** — Although Venus is Earth's closest planetary neighbor, there are many things about it that remain a mystery. Spectrographic observations (identification of materials according to the manner in which they absorb and emit light) suggest that the atmosphere of Venus contains carbon dioxide, but has probably little free oxygen or water vapor.

Earth-based measurements indicate temperatures of about 615°F and readings of −38°F in the upper atmosphere. Because of the tremendous distances over which these measurements were made, scientists cannot be sure of the exact altitude in the atmosphere where these temperature readings may apply.

*(Continued on page 37)*

*THIRTY-FOUR subcontractors to Cal Tech's Jet Propulsion Laboratory, manager of Project Mariner, provided instruments and hardware for Mariners I and II. These contracts totaled $6.5 million. Subcontractors were:*

| Company | Material |
|---|---|
| Aeroflex Corp.<br>Long Island City, N.Y. | Jet vane actuators |
| American Electronics, Inc.<br>Fullerton, Calif. | Transformer-rectifiers for flight telecommunications |
| Ampex Corp.<br>Instrumentation Div.<br>Redwood City, Calif. | Tape recorders for ground telemetry and data handling equipment |
| Applied Development Corp.<br>Monterey Park, Calif. | Decommutators and teletype encoders for ground telemetry equipment |
| Astrodata, Inc.<br>Anaheim, Calif. | Time code translators, time code generators, and spacecraft signal simulators for ground telemetry equipment |
| Barnes Engineering Co.<br>Stamford, Conn. | Infrared radiometers<br>planet simulator |
| Bell Aerospace Corp.<br>Bell Aerosystems Div.<br>Cleveland, Ohio | Accelerometers and associated electronic modules |
| Computer Control Co., Inc.<br>Framingham, Mass. | Data conditioning systems |
| Conax Corp.<br>Buffalo, N.Y. | Midcourse propulsion explosive valves<br>squibs |
| Consolidated Electrodynamics Corp.<br>Pasadena, Calif. | Oscillographs for data reduction |
| Consolidated Systems Corp.<br>Monrovia, Calif. | Scientific instruments<br>operational support equipment |
| Dynamics Instrumentation Co.<br>Monterey Park, Calif. | Isolation amplifiers for telemetry<br>operational support equipment |
| Electric Storage Battery Co.<br>Missile Battery Div.<br>Raleigh, N.C. | Spacecraft batteries |
| Electro-Optical Systems, Inc.<br>Pasadena, Calif. | Spacecraft power conversion equipment |
| Fargo Rubber Corp.<br>Los Angeles, Calif. | Midcourse propulsion fuel tank bladders |
| Glentronics, Inc.<br>Glendora, Calif. | Power supplies for data conditioning system |
| Groen Associates<br>Sun Valley, Calif. | Actuators for solar panels |
| Houston Fearless Corp.<br>Torrance, Calif. | Pin pullers |
| Kearfott Div.<br>General Precision, Inc.<br>Los Angeles, Calif. | Gyroscopes |
| Marshall Laboratories<br>Torrance, Calif. | Magnetometers and associated operational support equipment |
| Matrix Research and Development Corp.<br>Nashua, N.H. | Power supplies for particle flux detectors |
| Menasco Mfg. Co.<br>Burbank, Calif. | Midcourse propulsion fuel tanks and<br>nitrogen tanks |
| Midwestern Instruments<br>Tulsa, Okla. | Oscillographs for data reduction |
| Mincom Div.<br>Minnesota Mining & Mfg. Co.<br>Los Angeles, Calif. | Tape recorders for ground telemetry and data handling equipment |
| Motorola, Inc.<br>Military Electronics Div.<br>Scottsdale, Ariz. | Spacecraft command subsystems, transponders, and associated operational support equipment |
| Nortronics<br>A Division of Northrop Corp.<br>Palos Verdes Estates, Calif. | Attitude control gyro electronic, autopilot electronic, and antenna servo electronic modules, long range Earth sensors and Sun sensors |
| Ransom Research<br>Division of Wyle Laboratories<br>San Pedro, Calif. | Verification and ground command modulation equipment |
| Rantec Corp.<br>Calabasas, Calif. | Transponder circulators and monitors |
| Ryan Aeronautical Co.<br>Aerospace Div.<br>San Diego, Calif. | Solar panel structures |
| Spectrolab<br>A Division of Textron Electronics, Inc.<br>North Hollywood, Calif. | Solar cells and their installation and electrical connection on solar panels |
| State University of Iowa<br>Iowa City, Iowa | Calibrated Geiger counters |
| Sterer Engineering & Mfg. Co.<br>North Hollywood, Calif. | Valves and regulators for midcourse propulsion and attitude control systems |
| Texas Instruments Inc.<br>Apparatus Div.<br>Dallas, Tex. | Spacecraft data encoders and associated operational support equipment, ground telemetry demodulators |
| Trans-Sonics, Inc.<br>Burlington, Mass. | Transducers |

# ComSat Operation May Be Year Away

***Publication of list of incorporators, stock sale, naming of board and personnel still to come; a look at the regulations***

A PRIVATELY-OWNED Commercial Communication Satellite Corporation is at least six months to a year away despite final congressional approval of its enabling legislation.

Dr. Edward C. Welsh, executive secretary of the National Space Council, said last week that although a list of "incorporators" is being prepared for White House approval, it might be a year before the corporation is ready to begin operation.

He said the list of incorporators would be made public in the near future. Once this is done, a stock prospectus must be prepared for submission to the Securities Exchange Commission. Once the stock sale is completed, a board of directors will have to be selected and personnel hired.

Other government officials pointed out that while there will be some delay before the corporation is able to carry on "day-to-day" operations, technology needed by the system continues to move ahead. They pointed out that American Telephone & Telegraph Co. is slated to launch the second *Telstar* communications satellite in October and that NASA is preparing for the first launch of its *Relay* low-altitude satellite later this year.

The Communications Satellite Act was passed by the Senate on Aug. 17 by a vote of 66-11. The House approved the Senate bill and sent it to the White House by a vote of 365-10 on Aug. 27.

Final congressional action followed a weeks-long filibuster by Senate liberals against what they alleged was the bill's giveaway to AT&T.

• **Regulations**—As approved, the bill provides for establishment of a private corporation to set up a commercial communications satellite system. It would be regulated by the Federal Communications Commission.

The corporation will have a 15-man board of directors. The President is authorized to appoint three members, communications carriers owning stock in the corporation can elect six members, and private stockholders will elect six.

Up to 50% of the stock, selling at about $100 a share, could be owned by communication carriers. The remainder would be allotted to private investors.

The corporation will own the satellites and will lease the system's facilities to U.S. and foreign communication carriers. The ground stations may be built and owned by either the corporation or communication carriers. There is no provision to permit foreign communication carriers to own stock in the corporation or ground stations. The FCC was ordered, however, to oversee the establishment of communications by the corporation to any foreign point the U.S. State Department feels is desirable.

The two federal agencies playing the greatest role in the corporation's establishment and operation are NASA and FCC—with the latter having the far greater responsibility. Ironically, the space agency with its vast scientific staff can only advise the corporation on satellite technology. The final decision will be made by the FCC.

## New Procurement Bill Passes

Congressional bill HR 5532 tightening Pentagon procurement rules has been forwarded to the White House following House acceptance of Senate amendments. The bill's original provisions, limited by the House to incentive-type contracts, were later expanded by the Senate Armed Services Committee to cover the entire field of negotiated contracts.

Major purpose of the legislation is to assure that target cost information is current, complete and accurate. Contractors are required under the bill to certify this during negotiations. The legislation also carries a congressional policy statement that competition in defense contracting through formal advertising procedures should be encouraged wherever possible.

NASA will:

• Furnish to the corporation, on request and on a reimbursable basis, satellite launching and associated services required for the establishment, operation, and maintenance of the system.

• To the extent feasible, furnish other services on a reimbursable basis, to the corporation in connection with establishment and operation.

FCC is authorized to:

• Ensure effective competition, including the use of competitive bidding where appropriate, in the procurement by the corporation and communications common carriers of apparatus, equipment and services required for establishment and operation of the satellite system and terminal stations.

• Ensure that all present and future authorized carriers shall have non-discriminatory use of, and equitable access to, the communications satellite system and satellite terminal stations under just and reasonable charges.

• In any case where the Secretary of State, after obtaining the advice of NASA as to technical feasibility, has advised that commercial communication to a particular foreign point by means of the communications satellite system and satellite terminal stations should be established in the national interest, institute proceedings to require the establishment of such communication by the corporation and the appropriate common carrier or carriers.

• Ensure that facilities of the communications satellite system and satellite terminal stations are technically compatible and interconnected operationally with each other and with existing communications facilities.

• Approve technical characteristics of the operational system to be employed by the corporation and of the satellite terminal stations.

• Grant appropriate authorizations for the construction and operation of each satellite terminal station, either to the corporation or to one or more authorized carriers or to the corporation and one or more carriers jointly. ⌗

# AEROJET OPERATES COLUMBIUM LOOP WITH BOILING CESIUM OVER 2000 HOURS AT 1850°F



## Progress in Nuclear Space Power

Development of nuclear space power systems with a high power-to-weight ratio (in the range of 10 lb/kw) is predicated on the use of alkali metals as reactor heat transfer and turbine working fluids. Are the corrosion properties of these metals compatible with present design concepts of space power systems?

Work on the cesium-columbium system, under AEC sponsorship, began at Aerojet-General® Nucleonics on September 15, 1961, with operation of the first refractory metal loop specifically designed for forced-convection corrosion tests with boiling cesium. Specific-heat data were obtained, and on October 4 the loop was put on a continuous, long-term corrosion test, unattended, until December 27, 1961, when it was shut down for metallurgical analysis. A similar loop was tested successfully for the AEC in April 1961 with rubidium at 1850°F.

Besides demonstrating the feasibility of using columbium alloys to contain boiling cesium for extended periods at turbine inlet temperatures of 1850°F, the experimental work has yielded valuable information on the instrumentation and control of boiling loop systems.

AGN metallurgists have also developed new liquid metal handling and analytical techniques, and have constructed and operated apparatus for determining the density and vapor pressure of rubidium and cesium. Work is continuing on the heat transfer, corrosion, and thermophysical properties of cesium and other liquid metals to assure the long-term reliability of space power systems.

**AGN's Metallurgy Department contributes to materials technology in compact power reactors, space power systems, nuclear fuels, fissio-chemistry, and plasma physics.**

**AEROJET-GENERAL NUCLEONICS,** San Ramon, California

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# ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



## Missiles

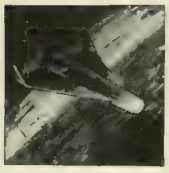
| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**ALFA** (Navy) | Navy, prime; Avco, air frame | ASW surface-to-underwater; weight—500 lbs.; solid motor; conventional HE depth charge; free-flight rocket; variable range (max. about 900 yds.) | Operational; deployed on destroyers and cruisers |
| **ASROC** (Navy) | Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control | ASW surface-to-underwater; solid motor; nuclear or conventional warhead, range about 8 miles; launch weight: 1000 lbs.; unguided | Operational on destroyers, destroyer escorts, heavy cruisers and guided missile frigates. Advanced ASROC (improved Mark 44 torpedo) under development |
| **ASTOR** (Navy) | Westinghouse, prime | Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional warhead; range, about 11 n. m.; solid motor | Development; to be deployed on hunter-killer submarines |
| ★**ATLAS** (Air Force) | STL, systems engineering & technical direction; GD/Astronautics, frame; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle; Acoustica, propellant utilization, propellant loading, A. D. Little Co. | ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series have inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability | Operational; 13 squadrons planned at 11 bases; already emplaced at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 54 launchers operational, ATLAS F being tested |
| **BOMARC** IM-99A (Air Force) | Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion | Ramjet surface-to-air interceptor; liquid booster; 200 n. m. range; Mach 2.5; nuclear; ceiling, over 68,000 | Five bases operational in Northeastern U.S. from Virginia to Maine, production completed |
| ★**BOMARC** IM-99B (Air Force) | Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion | Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear; production completed | First base operational May, 1961 two more planned; A-squadrons will be strengthened with advanced B model; production completed |
| **BULLPUP** GAM-83A, ASM-N-7A (Navy-Air Force) | Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime | Air-to-surface; 3-6 mile range; radio-link command guidance (visual reference); conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and I pre-packaged liquid motor; nuclear-tipped model nearly operational | Deployed with Atlantic and Pacific Fleets; operational with Air Force units. Marines tested launching BULLPUP from helicopters |
| **CORPORAL** (Army) | Firestone, prime; Gilfillan Bros., Inc., guidance; Ryan, propulsion | Surface-to-surface; 75 n. mi. range; liquid; nuclear; command guidance | Deployed with U.S. & NATO troops in Europe. SERGEANT to replace CORPORAL beginning in FY '63 |
| **DAVY CROCKETT** M-388 (Army) | In-house project directed by Army Weapons Command at Rock Island, Ill. | Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers: vehicle mounted or carried by two men | Operational in Europe; FY '63 budget funds provide for procurement of majority of inventory objective |
| **ENTAC** (Army) | Nord Aviation, prime | Antitank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided; man-portable | Operational; Army buying from French in quantity to replace SS-10 |
| **FABMDS** (Army) | GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies | Mobile antimissile defense system to provide an effective defense of the field army against enemy ballistic missiles | Feasibility studies submitted to ARGMA last year; evaluated by experts; future in doubt due to DOD doubts of its cost/effectiveness |
| ★**FALCON** GAR-1, 1D, 2, 2A, 3A, 4A, 9, 11 (Air Force) | Hughes, prime; Hughes, guidance; Thiokol, propulsion | Air-to-air; 5 n. mi. range; supersonic; solid; conventional; 1, 1D and 3A, active radar homing guidance; 2, 2A and 4A, IR homing; GAR-11 model has nuclear warhead and hybrid IR radar homing | Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under minimum effort development |
| ★**GENIE** MB-1 (Air Force) | Douglas, prime; Aerojet-General, propulsion | Air-to-air; unguided; 6-mile range; nuclear solid rocket; supersonic; proximity fuzing | Operational on F-101B & F-106 fighter-interceptors; improved version under development |
| **HAAW** (Army) | AOMC, prime | No details; Heavy antitank/assault weapon | Development; funds in FY '63 budget |
| **HAWK** (Army) | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion | Surface-to-air; 22-mile range; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles; improvements in system to be phased into production and furnished as modification kits to existing equipment | Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); '63 procurement will essentially complete deployment objective; Marines also procuring system |

★ **Indicates changes since July, 1962, Astrolog**

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **HONEST JOHN** M-50 (Army) | Douglas/Emerson Electric, prime; Hercules, propulsion | Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter and smaller; also developed a lighter-weight mobile launcher and an air-transportable launcher | Operational; deployed in Europe; to be replaced by MISSILE B |
| ★**HOUND DOG** GAM-77 (Air Force) | North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion | Air breathing air-to-surface standoff missile; about 600 n.-mi. range; Mach 1.7; turbojet nuclear B version in production, ceiling in excess of 50,000 ft. | Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; after SKYBOLT is operational, no. of missiles on a single B-52 will be increased from two to four |
| **JUPITER** SM-78 (Air Force) | Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle | IRBM; liquid; nuclear range: over 1500 mi.; guidance: all-inertial | Operational in Italy; 2 squadrons (30 launchers) with Italian AF; one squadron also deployed in Turkey |
| ★**LACROSSE** (Army) | Martin, prime; Martin/Federal Div. ITT, guidance; Thiokol, propulsion | Surface-to-surface mobile; 20-mile range; solid; nuclear | Operational; three units in Europe; eight activated; to be replaced by MISSILE B |
| **LITTLE JOHN** (Army) | Emerson Electric, prime; Hercules Powder, propulsion | Surface-to-surface unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands | Two battalions activated in '61; each equipped with four launchers; air and helicopter transportable |
| **M72** (Army) | Hesse-Eastern Div., Flightex Fabrics, prime | Light antitank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter; range 500 yd.; replaces 3.5 in. rocket launcher and rifle grenade; before type classification system known as LAW | Operational |
| **MACE** TM-76 A&B (Air Force) | Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; more than 650-mile range; turbojet and solid-nuclear; B model has more than 1200 mile range; inertial guidance in MACE B | Two MACE-A and one MACE-B squadron deployed with U.S. troops in West Germany; hardened facilities under construction in Germany; to be in Okinawa, Korea; replaced MATADOR in U.S. arsenal |
| ★**MATADOR** TM-61C (Air Force) | Martin, prime; Air Force, guidance; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; 500 mile range; speed, about 650 mph; ceiling above 35,000 ft. | Being turned over to West Germans; also deployed in Korea and on Taiwan |
| ★**MAULER** (Army) | GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; DeHaviland, IR acquisition | Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; tracked vehicle; 12 per launcher | R&D; NATO may buy; program to be accelerated in FY '63; Navy planning SEA MAULER for landing craft |
| ★**MOBILE MEDIUM-RANGE BALLISTIC MISSILE** (Air Force) | Program Definition Phase: Hughes & Northrop, integration, assembly and checkout; Ford Aeronutronic/Fairchild Stratos, Sperry Rand and Avco, re-entry system; Rocketdyne and Thiokol, propulsion; American Machine & Foundry and Goodyear Aircraft, transporter-launcher-erector; Hughes and Martin in association with Sylvania Electronic Products, command and control; General Precision, guidance | Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles | State-of-art missile to be developed in shortest possible time; to be deployed in Europe and Far East. Complex political questions of control and development funding within NATO delaying program |
| ★**MINUTEMAN** SM-80 (Air Force) | STL, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle | 2nd generation ICBM; solid; deployed in hardened and dispersed silos; nuclear; 3 stages; range: over 5000 miles; guidance: all-inertial; new, improved re-entry vehicle under development | Development; initial procurement late this year; scheduled to be operational mid-1962 at Malmstrom AFB; 3 squadrons at Malmtrom, Mont.; Ellsworth, S. D.; Whiteman Mo.; Minot, N. D.; 16 squadrons through FY '63, more in later years; mobile version killed |
| **M-55** (Army) | Norris Thermador, prime | Four-inch diameter, small, short-range rockets; for delivery of chemical agents; to be fired from 45-tube launchers | Operational both in U.S. and overseas |
| ★**MISSILE B** (Army) | 60 day Program Definition Contracts: Chrysler and Chance Vought Div., Ling-Temco-Vought | A highly-mobile general-purpose missile; range 3-30 miles; Autonet guidance; one missile per launcher; nuclear or conventional warhead; storable propellants | Funds available in FY '63 budget for initial development; eventually will replace HONEST JOHN and LACROSSE; division support weapon. Contract for development probably will be awarded in October, depending on results of program definition contracts |
| **NIKE-AJAX** (Army) | Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe | Surface-to-air; 25-mile range; Mach 2.5; solid and liquid; conventional | Deployed in U.S., Europe and Far East; 19 battalions still operated by National Guard are gradually being phased out |
| **NIKE-HERCULES** (Army) | Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe | Surface-to-air; 75-mile range; Mach 3+; nuclear; antiaircraft, tactical missiles; mobile or fixed | Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; increasing number to be manned by Army National Guard units; more than 10 N-H batteries were deployed overseas in 1961; N-H on Taiwan |
| ★**NIKE-ZEUS** (Army) | Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe | Anti-missile; 3-stage; 200-mile range; solid; nuclear | R&D test launchings at White Sands and Pt. Mugu; complete system tests at Kwajalein against ATLAS target vehicles have begun; one successful intercept announced July 19; earlier try "not completely successful" |
| ★**PERSHING** (Army) | Martin, prime; Bendix, guidance; Thiokol, propulsion | Surface-to-surface; two-stage solid; approx. 400-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range | Flight test program nearing completion; to replace REDSTONE. Procurement to begin this year; W. Germany buying; first battalion activated in June |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**POLARIS** (Navy) | Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle | Underwater and surface-to-surface; solid; 1200-n.-mi. range; A-1 installed aboard first six submarines; nuclear; A-2 (1500 n.-mi.) aboard submarines 7-19; A-3 (2500 n.-mi.) aboard 20th and all subsequent subs; possible A-4 4000-5000 mile range missile under study. Total POLARIS submarine program: 41 with six being added during FY '63 and final six during FY '64 | Five subs each with 16 missiles operational. A-2 scheduled to be operational in 1962; A-3 in 1964; SSBN Hamilton—first FBM sub equipped to use TRANSIT navigational satellite—launched in August |
| **QUAIL** GAM-72 (Air Force) | McDonnell, prime; Guidance Technology, Inc., guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment | ECM-carrying decoy; about 200 m. range; turbojet powered advanced version with 400 mile range has been flight tested | Deployed at SAC bases; carried by B-52; procurement completed FY '61 |
| **REDEYE** (Army) | GD/Pomona, prime; Philco/General Dynamics/Electronics, guidance; Atlantic Research, propulsion | Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable; for use against low flying aircraft | Development; plans for full production modified because of unsatisfactory tests; limited numbers will be procured in both FY '63 and '63; Marines also buying |
| **REDSTONE** (Army) | Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion | Surface-to-surface; liquid; 200-mile range; nuclear | Deployed with U.S. troops in Europe; to be replaced by PERSHING |
| ★**REGULUS I** SSM-N-8 (Navy) | Ling-Temco-Vought, prime; Sperry, guidance; Aerojet-General, propulsion | Surface-to-surface; turbojet and solid; 500-n.-mi. range; speed, about 600 mph; ceiling, approx. 40,000 ft.; nuclear | Deployed aboard 5 U.S. submarines and 2 cruisers; KDU-1: drone version; modernization program initiated during FY '61 to retrofit missiles with airborne guidance; retrofit to be completed by end of FY '62 |
| **SERGEANT** (Army) | Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion | Surface-to-surface; solid; more than 75-mile range; nuclear; inertial guidance employs drag brakes in terminal phase of flight | In production; procurement, except for training missiles, to be completed during FY '63; will replace CORPORAL; deployment in Europe in 1963 |
| ★**SHILLELAGH** (Army) | Ford Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance | Surface-to-surface; lightweight; vehicle-mounted for use against field fortifications, armor and close-in support of troops | Development; technical difficulties may force radical changes in system |
| **SHRIKE** (Navy) | NOTS-China Lake, prime; Texas Instruments, guidance | Air-to-surface; anti-radar; guidance, passive radar homing; solid motor; formerly called ARM | Development; first production buy in FY '63 budget |
| **SIDEWINDER** (GAR-8) (Navy-Air Force) | GE-Philco, prime; Philco/GE, guidance; Naval Propellant Plant, propulsion | Air-to-air; IR guidance; more than 2 m. range; conventional; new 1-C models to have switchable IR and radar-guided warheads and a new and improved rocket motor | Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version to start early in this calendar year |
| ★**SKYBOLT** GAM-87 (Air Force) | Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle | ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52 G and H and British Vulcan bombers | R&D; to be purchased by British; operational 1964; air drops from B-52 and Vulcan bombers successful; first R&D flight in April partially successful; second and third failures |
| **SLAM** (Air Force) | Ling-Temco-Vought, vehicles; Atomics International Div., NAA/Lawrence Radiation Labs, reactor; Marquardt, propulsion | Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph | Propulsion system being developed under project PLUTO; feasibility proven by highly successful TORY reactor tests; may be answer to DOD requirement for low-altitude missile to get under enemy radar defenses |
| ★**SPARROW III** AAM-N-6A (Navy) | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion | Air-to-air 5-8 mile range; Mach 2.5-3; ceiling, over 50,000 ft.; semi-active, CW homing, guidance; solid and pre-packaged liquid; conventional | Operational with carrier aircraft, earlier SPARROW I obsolete; production begun on advanced version (SPARROW III B) to be prime armament for F4H-1 interceptor; F3H-2 Demon also to carry III B—presently equipped with SPARROW III and III A; on Aug. 7, SPARROW III intercepted REGULUS RDU-1 drone |
| ★**SUBROC** (Navy) | Goodyear, prime; Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control | Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear | Operational aboard nuclear-powered attack sub Thresher; reportedly entire system was tested as part of current U.S. nuclear tests |
| **SS-10** (Army) | Nord Aviation, prime; GE, U.S. licensee | Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional | Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC |
| ★**SS-11** (Army) | Nord Aviation, prime; GE, U.S. licensee | Surface-to-surface; antitank; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional | Operational, to be used with airborne units and Army helicopters |
| ★**TALOS** (Navy) | Vitro, systems engineering; Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Sperry, guidance | Ship-to-air; 65-mile range; solid and ramjet; Mach 2.5; nuclear; radar beam riding/semi-active homing guidance | Operational aboard cruisers Galveston, Oklahoma City and three heavy cruisers; Long Beach, first nuclear-powered missile cruiser, to carry advanced TALOS |
| ★**TARTAR** (Navy) | Vitro, systems engineering; GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion | Ship-to-air; 10-mile range; Mach 2; 15 feet long and 1 foot in diameter; radar beam-riding guidance; solid dual-thrust motor; conventional | Operational; installed aboard 6 guided missile destroyers and as backup on heavy cruisers equipped with TALOS; advanced version with greater range and improved performance available in 1962 |
| **TERNE** (Navy) | Kongsberg Vapenfabrikk, prime; Arma, systems integration | Surface-to-underwater ASW missile; 264 lbs; HE warhead | Navy buying from Norway to equip two destroyer escorts |
| ★**TERRIER** SAM-N-7 (Navy) | Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, Sperry, guidance; ABL, propulsion | Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional; 2 greatly improved versions now becoming operational | Operational aboard one attack carrier (Kitty Hawk), one light cruiser (Springfield) and six guided missile frigates; also used by Marines for beachhead operations |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**THOR** SM-75 (Air Force) | Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle | Surface-to-surface IRBM; 1500-mile range; liquid; nuclear guidance, all inertial | Operational; 4 bases (60 launchers) in England to be closed by British |
| ★**TITAN** SM-68 (Air Force) | STL, systems engineering and technical direction; Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle | Surface-to-surface ICBM; 5000-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long; TITAN II to be used as basic core vehicle for TITAN III space booster | 8 bases for 12 squadrons planned; TITAN I squadron at Lowry AFB declared operational in April; TITAN II scheduled operational early 1963; TITAN II undergoing flight test; TITAN II will also be used for GEMINI program |
| ★**TOW** (Army) | Hughes, prime | Tube-launched, optically tracked, wire guided, HE warhead | Follow-on to ENTAC; Hughes won feasibility demonstration with a reported 8,000 fps missile |
| ★**TYPHON** (Navy) | Bendix, missile; Westinghouse, weapons direction system and radar; McDonnell, propulsion | Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional, supersonic | Development; successor for TALOS, TARTAR and TERRIER; expense of system may delay deployment. Norton Sound is being converted; and a nuclear powered frigate is being built for the system |
| **ZUNI** (Navy) | Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion | 5-inch, air-to-surface; solid; unguided; 5 n.-mi. range conventional | Operational; designed for use on jet fighter and attack aircraft |



# Satellites and Spacecraft

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| ★**ANNA** (Army, Navy, AF, NASA) | Bureau of Naval Weapons/Applied Physics Lab, prime; AF Electronics Systems Div./Edgerton, Germeshausen & Grier, flash tube experiment; Army Engineers/Cubic Corp., CW transmitter | Geodetic satellite; 600-mi. orbit; 36-in aluminum sphere (with solar cell belt, 48 in.); weighs 355 lbs.; boosted by THOR-ABLE STAR; 2 sets of xenon flash tubes produce series of 5 light flashes about 20 times a day as triangulation point; transmitter provides range determination through Doppler shift observations | Development; first launch failed May 10; second launch planned in August postponed due to radiation effects from U. S. July 9 nuclear test; launch now set for October; NASA may assume responsibility for expanded program in 1964 |
| ★**AEROS** (NASA) | No contract announced | 24-hour weather satellite earth stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster, ATLAS-AGENA or CENTAUR | Planning. First flights would be in 1964 or 1965; development of prototype hardware, including TV cameras, to be accelerated in FY '63 |
| ★**APOLLO** (NASA) | North American, Command & Mission Modules, systems integration; MIT, guidance development; tele-communications, Collins Radio; stabilization & control, Minneapolis-Honeywell; environmental control, AiResearch; parachute recovery, Radioplane; escape tower rocket, Lockheed Propulsion Co.; Reaction controls, Marquardt | Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN for earth orbits; Advanced SATURN (C-5) for lunar rendezvous; NOVA for direct flight. 3-modular spacecraft: command module, 5 tons, 12 ft. high; service module, 23 tons, 23 ft. high; lunar excursion vehicle, 15 tons, 20 ft. high; total weight: 85,000 lbs. | Earth orbital shots scheduled 1964-65; lunar orbits 1966; lunar landing, 1967-68. Mission profile, lunar orbit rendezvous selected in early July; 11 firms asked to submit bids for development of lunar excursion vehicle |
| **ARENTS** (ARPA) | GD/Astronautics, prime | Series of three satellites to investigate space environment of 22,000-m. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster | Contract let to build three payloads; launchings aboard a NASA payload; program reevaluated due to CENTAUR delay. NASA pursuing almost identical program: 3 satellites, 24-hour orbit radiation environment investigations |
| ★**AEROSPACE PLANE** (AF-NASA) | No contracts announced | Manned, hypersonic spacecraft capable of earth-to-orbit-and-return; turbofan, 0-3 Mach; ramjet, 3-8 or 10 Mach (oxygen collected and liquified during this cycle); 8 to 10 Mach-orbital speeds, $LH_2$-LOX rocket; minimum life of 100 flights reportedly a requirement; also being considered as a 5000-mile aircraft without refueling | NASA-AF set up ad hoc committee to prepare joint research program; group to report this month; DOD funding component development program in FY '63 of $19 million; big development effort possible in FY '64; craft could be in operation by about 1970 |
| **BAMBI** (ARPA) | GD/Astronautics, STL | Satellite system capable of intercepting enemy missiles in boost phase using space based platforms and interceptors | Feasibility still unproved; additional research under way |
| **BOSS** (Bioastronautics Orbiting Space Station), Program 698AA (Air Force) | Lockheed, AiResearch | Recoverable capsules with primates aboard; capable of orbital flights up to two weeks; six shots planned using ATLAS-AGENA; both circular orbits below radiation belt and elliptical orbits through the belts planned | Originally joint AF-NASA program; however, DOD disapproved AF participation; NASA considering funding entire $76 million program in FY '64 |
| **COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE** (AF-DCA-Army) | No contracts announced | Multiple-launch, active repeater comsat; 40-50 satellites in 5000-7000 mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster; narrow bandwidth, voice and teletype communications equipment | One of two systems resulting from reoriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966; to use ADVENT ground stations; responsibilities: AF, satellite; Defense Communications Agency, interface problems; Army, ground environment |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE** (AF-DCA-Army) | No contract announced | 24-hour, station-keeping, active repeater comsat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment with encryption and anti-jamming capabilities; booster, ATLAS-AGENA | Second system evolved from ADVENT; initial capability, 1964; operational, 1966; responsibilities: same as medium-altitude system |
| **DISCOVERER** (Air Force) | Lockheed, prime; GE, re-entry vehicle | THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems | Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program |
| ★**DYNA-SOAR (X-20)** (Air Force) | Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link. Auxiliary Power, Sundstrand. Project ASSET, McDonnell | Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster | Development; officially redesignated X-20, but either name may be used; program reoriented and suborbital flights eliminated, design details finalized during 1961; Project ASSET will test structural integrity, using BLUE SCOUT; first DYNA-SOAR flight scheduled for 1965; air drops from B-52 likely in late 1963 or early 1964 |
| ★**ECHO** (NASA) | Langley Research Center, prime | ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital; functioning of sphere will be tested by monitoring its reflectivity to radio waves by measuring its radar cross-section | ECHO I in orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; first of two ballistic shots planned this year from AMR successful; orbital launch from PMR also planned during FY '63 |
| ★**GEMINI** (NASA) | McDonnell prime; Rocketdyne, spacecraft propulsion; fuel cell, General Electric | Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched; AGENA will be used for rendezvous missions. 12-15 spacecraft will be produced. Of the 12-15 flight missions, at least 8 will involve rendezvous and docking operations | Development; will be used to determine feasibility of rendezvous for lunar mission; also to test men and components for APOLLO; first unmanned flights, 1963; manned and rendezvous flights, 1964-65 |
| **LUNAR LOGISTICS VEHICLE** (NASA) | 11 firms competing for vehicle study contract; 13 for payload study | 1500-lb. spacecraft bus to carry support payloads to the Moon; initial use on SATURN C-1B; later 20,000 lb. bus would be used with C-5; seven specific payloads will also be studied | Development expected to begin in 1963 after Congressional approval of FY '64 funds; Cost expected to run to $500 million; study contracts to be awarded in October |
| ★**MANNED ORBITING DEVELOPMENT STATION** (Air Force) | No contractors announced | Manned space station for testing components and techniques in the space environment; also considered important as a source of astronaut training to provide reservoir of experienced space pilots for military missions | Program not approved for development; but strong indications DOD will approve it in FY '64 budget; AF spending approx. $6 million in FY '63 for studies; NASA also planning orbiting lab for 1966-67 time period |
| **MANNED SATELLITE INTERCEPTOR** (Air Force) | No contracts announced | Spacecraft capable of rendezvousing, inspecting and, if necessary, neutralizing hostile satellites | Termed "absolutely essential" by the AF, program is being held up by DOD; study contracts for system to North American, Lockheed, Boeing, McDonnell, Hughes and Raytheon by SSD cancelled at DOD direction |
| ★**MARINER** (NASA) | JPL, prime | 450-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B 1000-lb. MARINER B also under development | Twelve shots planned. First scheduled Venus fly-by Aug. 1962 unsuccessful after booster failure; second successfully launched Aug. 27; six MARINER B flights in 1963, two in 1964 (ATLAS-AGENA); '64-'65 flights will use CENTAUR |
| ★**MERCURY** (NASA) | McDonnell, capsule | First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE | First manned orbital flight Feb. 20, 1962 by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra set for late September; one more flight likely; modified MERCURY will make 18-orbit flights next year |
| ★**MIDAS, PROGRAM 239A** (Air Force) | Lockheed, prime; Aerojet IR detector system | Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads | Development; program being re-oriented from precise orbit satellite system to random orbit system due to technical difficulties with IR system; pushed back into development cycle with no plans for operational system approved. All program data classified by DOD direction |
| ★**NIMBUS** (NASA) | Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras | 2nd generation weather satellite; Earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster | First launching scheduled for late this year; second, six months later; four R&D satellites and four Weather Bureau satellites presently planned |
| ★**OAO** (NASA) | Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers | 3500-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; boosted by SATURN C-1 | First flight scheduled in 1964; two more in 1965 |
| ★**OGO** (NASA) | Space Technology Laboratories, prime | 1000-lb. satellites with instruments for geophysical measurements polar (POGO) and eccentric (EGO) shots planned; capable of accommodating up to 50 experiments; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters | First flight scheduled in 1963; 19 experiments planned for first shot; nine other shots planned—one in '63 and four each in '64 and '65 |

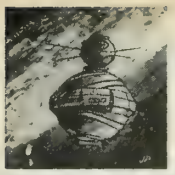
| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**OSO** (NASA) | Ball Brothers, prime | 440-lb. orbiting solar observatory; THOR-DELTA and ATLAS-AGENA booster, S-16 early version; S-17 and S-57 advanced versions | First flight March 7, 1962, highly successful; first flight for S-17 planned for 1962; satellite stopped sending useful data in May resumed in July as spin rate decreased; 10 more flights planned; advanced OSO design studies awarded to Ball Bros., Republic and STL |
| ★**RANGER** (NASA) | JPL, prime; Aeronutronic, capsule; Hercules, retrorocket | 300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera tapes pictures of lunar surface; ATLAS-AGENA B booster | R&D; first two RANGERS failed to launch from orbit; RANGER III launched Jan. 26, failed to impact Moon, went into solar orbit; RANGER IV impacted on Moon April 26; RANGER V scheduled for October; nine RANGERS planned; all during 1962 and 1963 |
| **REBOUND** (NASA) | No contract announced | System of three rigidized multi-launched low-orbit passive communications satellites; follow-on to ECHO. Satisfactory design completed in March. ATLAS-AGENA booster | First orbital flight scheduled for 1963; experiments to be conducted jointly with Air Force |
| ★**RELAY** (NASA) | RCA, prime | 150-lb., spin-stabilized, wide-band, 700-3000 mile orbit active repeater experimental communications satellites. Spacecraft will contain two complete and separate communications transponders each capable of handling a standard TV channel or 12 two-way voice channels. DELTA booster | Britain, France, Brazil and Germany building ground stations; two launchings planned in 1962; two more in 1963; advanced RELAY to receive and transmit radio and TV signals by way of 600-lb. satellite in 12,000-mi. circular orbit under study; ATLAS-AGENA booster; three launches planned for 1964; study contract due this year |
| ★**SATELLITE INSPECTOR, PROGRAM 621A** (Air Force) | RCA, prime; Hughes, detection equipment | Anti-satellite inspection system; capable of orbital plane and altitude changes to rendezvous within 50 ft. of target; to be complemented by interception system; about 2 tons; ATLAS-AGENA B launched | R&D; formerly known as SAINT; during March, 1961, contracts let to design, fabricate and test the spacecraft; program appears behind schedule since feasibility demonstration was due early this year |
| ★**SAMOS** (Air Force) | Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura | Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300 mile circular polar orbit | Development; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; all program information classified by DOD direction |
| **SERT** (NASA) | RCA, prime | Spinning satellite carrying two electric-propulsion engines for environmental tests | SERT I to be launched last quarter 1962 with Hughes and Lewis Center engines |
| **SLOMAR** (Air Force) | Lockheed and Martin, study contracts | Logistics, maintenance, supply spacecraft for space systems | Study contracts awarded in Dec., 1960; DOD studying concepts in connection with Manned Orbiting Development Station |
| ★**SURVEYOR** (NASA) | Hughes, prime; Martin, SNAP device | 750-lb. spacecraft soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; also Moon orbiting vehicle planned; SNAP II nuclear power generator to be used | First Moon flights 1964; seven soft-landing vehicles planned; five lunar orbiters to transmit pictures of the surface also scheduled |
| ★**SYNCOM** (NASA) | Hughes, prime | 24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in diameter and will weigh about 55-lbs. without weight of injection motor; capable of accommodating one full duplex radio telephone channel; initial inclination to be 30 degrees | Development; three launchings using THOR-DELTA scheduled during FY '63; 500-lb. advanced SYNCOM with wide band capability (4 TV channels or 300 two-way telephone channels) to be developed in FY '63; 2 flights with ATLAS-AGENA planned for 1964; one in 1965; remarkably similar to new DOD program |
| ★**TELSTAR** (AT&T-NASA) | BTL, management for AT&T | 170-lb., active repeater, experimental industry communication satellite; DELTA booster. To be launched into 3000-mile orbit by NASA on cost-reimbursed basis | Development; two to four satellites planned for launch in 1962; first launch July 10 highly successful |
| ★**TIROS** (NASA-Wea. Bu.) | RCA, prime | 285-lb. meteorological satellite; TV pictures of cloud cover; TIROS II and III carried IR scanner. TIROS V doglegged into orbit which will enable satellite to obtain data on ice-breakup in Northern hemisphere | R&D; first launching April, 1960; second Nov. 23, 1960; third last July 12, fourth Feb. 8, all successful; TIROS V successfully launched June 19; two more launches planned; both in 1962 |
| ★**TRANSIT** (Navy) | Applied Physics Laboratory, prime; Martin SNAP device | Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs.; operational system: four satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; THOR-ABLE-STAR booster | Operational system scheduled to be in orbit by last quarter 1962 to initially be used by POLARIS subs and greatly reduce the position errors of these subs |
| **VELA-HOTEL** (ARPA) | STL, prime; Los Alamos Scientific Lab/ Aerospace, payload | 12-sided, 300-400-lb. satellite for detection of nuclear explosions in space; 60,000-n.-mi. orbit; three satellites placed in one orbital plane with three more in a plane 90° to the first; booster, ATLAS-AGENA | Initial launchings expected during this calendar year |
| ★**VOYAGER** (NASA) | JPL | Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface. Capsule will then communicate with Earth through orbiting spacecraft; SATURN booster; weight approx. 2400 lbs. | Study; design and development to begin this year; first flight planned by 1965; Mars orbital flight scheduled in 1966 |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
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| ★**X-15** (NASA-AF-Navy) | North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics | Manned rocket plane; capable of 4000 mph flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 57,000 lbs. Three planes delivered; role expanded to include testing of spacecraft components and space research. Current re-entry high angle of attack flights providing basic flight data for DYNA-SOAR program | Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #3 set new unofficial altitude record of 314,750 ft.; plane #1 set new unofficial speed record for manned powered flight of 4159 mph |



# Space Vehicles

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| ★**AGENA** (Air Force) | Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion | 1700-pound upper stage designed to go into orbit with payload; all-inertial guidance; 16,000 lbs. thrust propellants: IRFNA/UDMH; AGENA B has re-start capability. AGENA D, improved version of B model, undergoing flight tests | Used in DISCOVERER, SAMOS and MIDAS programs; used with ATLAS and THOR; 1st flight test of AGENA D in June; second, Aug. 1 |
| ★**BLUE SCOUT** (Air Force) | Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion | 4-stage vehicle; speed, more than 20,000 fps; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance; weight, 35,475 lbs. | Operational; based on NASA's SCOUT; used as space probe and small (150-lb.) satellite launch vehicle; also used as AF's Hyper-Environmental Test System |
| ★**CENTAUR** (NASA) | GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance | High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS D booster, capable orbiting 8500 lbs.; 2300 lbs. to escape velocity and 1300 lbs. on planetary flights | Development; first flight test failed when $LH_2$ tank shielding broke off 54 secs. after launch; program still slipping; however, NASA plans to continue it |
| **DELTA** (NASA) | Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion | Successor to THOR-ABLE; upper stage guidance; 3 stage vehicle; 500 lb. payload capability in 345 mile orbit; 60 lbs. to escape | Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA |
| ★**NOVA** (NASA) | General Dynamics/Astronautics and Martin awarded design study contracts | 1st Stage: 8-12 F-1 engines; 2nd Stage: 2 or more M-1 engines; 3rd Stage: 1 J-2 engine; Payloads: 240-350 tons in 345 mile orbit; 75 tons to escape; 50 tons planetary probe (liquid) | R&D on 1.5 million lb. F-1 engines; solid first stage may be developed later; alternative to advanced SATURN (Rendezvous) and ROVER nuclear rocket; operational target date 1970 |
| **ORION** (Air Force) | General Atomic | Space booster propelled by series of atomic explosions | Studies only |
| ★**ROVER** (NASA, AEC) | Lockheed, vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion | First nuclear rocket: KIWI B | First Rover flight test expected 1966-67; operation vehicle 1968-69; to be compatible with both ADVANCED SATURN and NOVA launch vehicles; reactor for NERVA engines to be selected by end of the year |
| ★**SATURN C-1** (NASA) | Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas | 2-stage vehicle for early orbital tests of APOLLO and various space programs. 1st stage: 8 Rocketdyne H-1 engines using LOX/RP; 2nd stage: 6 Pratt & Whitney RL10-A3 engines using LOX/$H_2$; 20,000 lbs. into 345-mi. orbit | First C-1 launching Oct. 27, 1961 from Cape successful; second April 24, 1962; both flights with inert upper stage; first flight with live upper stages 1963; S-IV stage successfully static-tested by Douglas in August |
| **SATURN C1-B** (NASA) | Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas | S-1: 8 H-1, LOX/RP engines total thrust 1.5 million lbs.; S-IVB: 1 J-2 LOX/$LH_2$ engine with 200,000 lbs. thrust; payload capability, 30,000 lbs. in 345-mi. orbit | Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; may also be used as a supply vehicle |
| ★**SATURN C-5** (Advanced Saturn) (NASA) | Systems engineering, assembly and guidance, Marshall Center; S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American | S-1B: 5 F-1 engines; S-II: 5 J-2 engines; S-IVB: J-2 engine; 1st stage: LOX/RP; Upper stages, LOX/$H_2$; 100 ton payload in 345 miles orbit; 43 tons to escape velocity; 30 tons, planetary missions | R&D; first flight scheduled for 1965; prime booster for APOLLO missions; will also be used to boost Orbiting Space Station |
| **SCOUT** (NASA) | Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion | Solid four-stage satellite launcher; 150 lb. payload in 345 n.-mi. orbit; also, used as space probe vehicle | SCOUT flights in '61 completed R&D; payload capability being increased to 250 pounds |
| ★**THOR-ABLE-STAR** (Air Force-NASA) | STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion | Three-stage vehicle, orbital capability about 900 lbs. in 300 mi. orbit; upper stage has restart engines | THOR-ABLE phased out. Used in TRANSIT, ANNA, COURIER, and COMPOSITE satellite programs |
| ★**TITAN III** (Air Force) | Martin, systems, integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance | Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance | Development; first flight late 1963; 17 development flights planned (12 TITAN II core vehicles, 5 full TITAN III's); development program to cost $808 million; prime booster for military, and some NASA missions, for next 10 years; operational in 1965; as many as 30 launches per year foreseen |



# Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits Earth; perigee 364 km, apogee 1688 km, period 105.5 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits Earth; perigee 656 km, apogee 3941 km, period 133.9; transmitting 108.024 mc.

**LUNIK I "MECHTA"** (3245 lbs.) Russia. Launched 1/2/59. In orbit around Sun on 450 day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits Earth but is "wobbling"; perigee 588 km, apogee 3262 km, period 125.3; not transmitting.

**PIONEER IV** (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun on 398 day cycle; apogee 1.142 au, perigee 0.981 au; achieved primary mission—Earth-Moon trajectory; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits Earth; perigee 516 km, apogee 3719 km, period 129.7; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits Earth; perigee 557 km, apogee 1072 km, period 101.1; not transmitting.

**PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun on 311.6 day period; interplanetary environment probe; aphelion .9951 au, perihelion .8061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits Earth; picture-taking weather satellite; perigee 710 km, apogee 731 km, period 99.1; transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits Earth; perigee 350 km, apogee 643 km, period 94.5. First R&D navigation satellite. Not transmitting.

★**SPUTNIK IV** (10.008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits Earth; perigee 221 km, apogee 256 km, period 89.3. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload and one piece still in orbit. Not transmitting.

★**MIDAS II** (5000 lbs.). U.S. Launched 5/24/60, est. life 8-15 years. Orbits Earth; perigee 439 km, apogee 538 km, period 94.2. Telemetry for IR scanning failed two days after launch. Not transmitting.

**TRANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits Earth, perigee 608 km, apogee 1063 km, period 101.6. Transmitting 162; 216 mc.

★**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits Earth; perigee 613 km, apogee 1056 km, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits Earth; perigee 1151 km, apogee 1849 km, period 115.9. First successful orbiting of passive communication satellite.

★**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits Earth; perigee 962 km, apogee 1217 km, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

**EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits Earth; perigee 413 km, apogee 2266 km, period 112.4. Provided ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits Earth; perigee 610 km, apogee 740 km, period 98.2. Not transmitting.

**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits Earth; perigee 465 km, apogee 552 km, period 94.9. First R&D reconnaissance satellite.

**VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61. Orbits Sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits Earth; perigee 728 km, apogee 2445 km, period 117.8. A 12-ft. "polka dot" balloon.

**EXPLORER X** (78 lbs.) U.S. Launched 3/25/61. Optical pumping magnetometer. Position uncertain.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits Earth; perigee 487 km, apogee 1782 km, period 107.8. Measures gamma rays from the stars absorbed in Earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits Earth; TRANSIT—perigee 877 km, apogee 1001 km, period 103.8. GREB-INJUN—perigee 878 km, apogee 1001 km, period 103.8. Transmitting. IVA: 54; 150; 324; 400. GREB-INJUN: 136.5. GREB III and INJUN failed to separate.

**TIROS III** (285 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 745 km, apogee 811 km, period 100.30. Transmitting cloud cover weather pictures.

★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 3401 km, apogee 3489 km, period 161.5. IR early warning satellite.

★**EXPLORER XII** (83 lbs.) U.S. Launched 8/16/61. Insufficient observations. Study Van Allen belts and energetic particles in space.

**MIDAS IV** (3500 lbs.) U.S. Launched 10/21/61. Orbits Earth; perigee 3512 km, apogee 3739 km, period 166.0. IR scanning early-warning satellite.

★**DISCOVERER XXXIV** (2100 lbs.) U.S. Launched 11/5/61. Orbits Earth; perigee 230 km, apogee 636 km, period 93.3. Malfunction in orbit forced abandonment of usual attempt to recover capsule.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits Earth; perigee 946 km, apogee 1116 km, period 105.6. Satellite is an operational prototype of the Navy's navigational satellite. Solar cells damaged by radiation from U.S. July 9 nuclear test.

★**TRAAC** (200 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits Earth; perigee, 952 km, apogee 1112 km, period 105.6. Designed to test new system of stabilization based on the Earth's gravitation field. Also designed to supply data on the Van Allen belt. Solar cells damaged by radiation from U.S. July 9 nuclear test.

★**RANGER III** (727 lbs.) U.S. Launched 1/26/62. Orbits sun on 406.4 day cycle; probe failed to impact, went into heliocentric orbit; aphelion 1.163 au., perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits Earth; apogee 853 km, perigee 697 km, period 100.3; weather satellite to gather cloud cover pictures and IR heat balance data. Transmitting 136.23; 136.92 mc.

★**ORBITING SOLAR OBSERVATORY** (440 lbs.) U.S. Launched 3/7/62. Orbits Earth; perigee 548 km, apogee 593 km, period 95.9; payload consisted of 13 experiments to study solar radiations, investigate dust particles in space and thermal radiation characteristics of spacecraft surface materials. Resumed transmitting on 136.744 mc. in latter part of June after stabilization lapse on May 22.

**COSMOS II** (?) Russia. Launched 4/6/62. Orbits Earth; perigee 213 km, apogee 1294 km, period 99.8; second in a series of space environmental research satellites; transmission data not known.

★**COSMOS III** Russia. Launched 4/24/62. Orbits Earth; perigee 221 km, apogee 524 km, period 91.9; third of a series and intended to study weather, communications and effects of radiation on man during prolonged space flights.

**ARIEL: INTERNATIONAL SATELLITE** (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 390 km, apogee 1209 km, period 100.8; first joint satellite (U.K. built payload; U.S. supplied booster, satellite structure and tracking facilities) to study the ionosphere and the intensity of cosmic radiation. Solar cells damaged by radiation from U.S. July 9 nuclear test.

**COSMOS V** (?) Russia. Launched 5/28/62. Orbits Earth; perigee 199 km, apogee 1434 km, period 101.2; another Soviet satellite for space environmental research. Transmitting.

**TIROS V** (285 lbs.) Launched 6/19/62. Orbits Earth; perigee 589 km, apogee 974 km, period 100.5. IR components & one TV camera not functioning but satellite still expected to provide data on the breakup of ice in northern latitudes as well as on the growth of hurricanes. Transmitting 136.235; 136.922 mc.

**COSMOS VI** (?) Russia. Launched 6/30/62. Orbits Earth; perigee 262 km; apogee 279 km, period 89.8. Continuation of Soviet-announced space environmental research program. Not transmitting.

**TELSTAR I** (170 lbs.) Launched 7/10/62. Orbits Earth; perigee 952 km, apogee 5635 km, period 157.7. AT&T-developed experimental, active repeater communications satellite to study feasibility of low-altitude system and measure the effects of radiation on satellite systems and lifetime; successfully transmitted transatlantic TV, telephone and radio traffic. Transmitting 136.05 mc.

**COSMOS VIII** (?) Launched 8/18/62. No orbital data available. Part of space research program begun five months ago, according to TASS.

**SECRET AF SATELLITES:**

- Launched 3/7/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 244 km, apogee 586 km, period 92.9.
- Launched 4/9/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 2816 km, apogee 3379 km, period 153.0.
- Launched 5/15/62. wt. unk. THOR-AGENA B. Orbits Earth; perigee 297 km, apogee 628 km, period 93.7.
- Launched 6/18/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 366; apogee 403, period 92.3.
- Launched 6/28/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 192 km, apogee 516 km, period 91.7.
- Launched 7/21/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 177 km, apogee 177 km, period 88.1.
- Launched 7/28/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 188 km, apogee 347 km, period 89.9.
- Launched 8/2/62. wt. unk. ATLAS-AGENA D. Orbits Earth; perigee 194 km, apogee 366, period 90.2.
- Launched 8/5/62. wt. unk. ATLAS-AGENA. Orbits Earth; no other data available.
- Launched 8/23/62. wt. unk. BLUE-SCOUT. Orbits Earth; no other data available.

# Technical Countdown

## ADVANCED MATERIALS

### Helium Closed-Cycle Refrigerator Hits —455.2°F

A closed-cycle refrigeration system able to achieve and hold a temperature within 2.5 degrees of absolute zero has been designed and built by Air Products and Chemicals, Inc. The system was specifically developed for maser applications, but is also adaptable to other cooling jobs such as superconducting magnets and computer memory planes. The unit uses oil-free compressors and expanders, since the slightest contamination of the helium working fluid will cause a malfunction. The system will reach temperature within three hours and is designed for field use of up to three months operation without maintenance. The development evolved from a contract with Bell Telephone Labs for the U.S. Army Ordnance Missile Command.

### OAO Starts 39-Day Vacuum Test

The longest single thermal vacuum test of a space satellite is under way at Grumman Aircraft Engineering Corp. On Aug. 21, a structural model of the *Orbiting Astronomical Observatory* was loaded into a huge environmental chamber for 39 days of constant exposure. The test is aimed primarily at checking out the satellite's passive temperature control system, ending 1.5 years of exhaustive thermal analysis covering every section of the 10-ft. OAO. Structural distortion is being measured to within a few seconds of arc using pendulum-type transducers. Distortion measurement is necessary for development of the satellite's extremely precise stabilization and control system.

### Satelloon Contract Awarded

Two 135-ft.-dia. inflatable communications satellites will be fabricated with a new chemically milled, plastic-to-metal lamination by G.T. Schjedahl Co. under a $200,000 NASA contract. The spheres will meet the same dimensional specs as *Echo A-12*. Static inflation tests to be made this month will determine use of the material in communications projects such as *Rebound*. The material consists of a sandwich of ultra-thin aluminum bonded to a center piece of biaxially oriented polypropylene. Milling eliminates more than 60% of the aluminum, leaving tiny hexagonal "windows" which cut down the effect of solar radiation on such inflated satellites.

### Dry-Bonded Circuit Usage Expands

New England Laminates Co., developers of a new chemically dry bonding scheme for packaging multi-layer, high-density printed circuits, reports the technique is being used on a pre-production basis by five major aerospace firms. Company officials claim significant improvements in reliability and circuit performance over so-called "wet lay-up" systems. In the Nelco Dri-Pli process, fully cured, ultra-thin, copper-clad epoxy glass laminates are bonded by an epoxy resin-impregnated woven glass fiber cloth inserted between circuit layers. The package is unitized by hydraulic pressure and heat from a standard press. At present, from three to eight circuits can be produced with the system.

### Fine Grain W-Alloy Ingots Produced

Oregon Metallurgical Corp. has succeeded in producing fine-grain, high-tungsten alloy ingots through a rapid cooling operation coupled with centrifugal force. Oremet has produced equiaxed-grain ingots of 7 in. dia. Ingots have been upset-forged and ring-rolled into cylinders. Rods of varying diameters have also been directly swaged from the as-cast product. The alloy is a tungsten-molybdenum combination.

## PROPULSION

### Rocketdyne Expands in Solids

Two casting and curing pits, two propellant mix buildings and a non-destructive test facility will be completed next month at Rocketdyne's McGregor, Tex., facility (Air Force plant 66) in the first phase of a $2.3-million expansion program. The first phase alone will provide a 50% increase in propellant processing capability—an additional 12 million lbs. of high-energy castable propellant per year. Motors up to 160 in. across and 25 ft. long can be handled. Next on the program is construction of a 1.5-million-lb.-thrust firing stand and rehabilitation of the test control center and oxidizer processing buildings.

### Uncured Propellant Analyzer Perfected

Scientists at Redstone Arsenal have developed an X-ray emission method to completely analyze uncured solid propellant samples in less than 15 min. The process, conceived by Bernard Alley and James Higgens of the Propulsion Lab, can determine the ingredients in the propellant "soup," the amount of each and also particle size. The process is also being used as a quality control device involving pellets identical to the propellant under examination. Random samples placed in an X-ray machine with the pellets are checked for radiation differences. Analytical process time has been cut from a day with the new method.

## ELECTRONICS

### Army Micromodule Program Expands

The Army's Chief Signal Officer, Maj. Gen. Earle F. Cook, speaking in New York last week, said the service would commit about $8 million of its FY '63 budget for micromodule equipment and systems—double the 1962 figure. The Army-industry team conducting the program, says Gen. Cook, will reach a production rate of 250,000 micromodules a year by March, 1963, a million a year by June, 1964, and 3 to 5 million annually in 1965 under existing plans. RCA holds the prime Signal Corps program contract and is supported by about 61 other contributing firms.

### Gemini Digital Command to Motorola

Motorola's Western Electronics Division will develop the digital command system for the *Gemini* orbital capsule. The equipment consists of r-f command receivers, decoders and a buffer storage unit. Proved Motorola components such as those in the *Mercury* will be used. Specified mean time between failures is approximately 17,000 hrs.

### NSF To Conduct Free Balloon Flights

Five free balloon flights will be sponsored by the National Science Foundation beginning in mid-October and continuing at the rate of one every 30 days. Dubbed "Polariscope," the launches will be conducted by the National Center for Atmospheric Research, Boulder, Colo., to study diffuse radiation, its polarization, its variation with ozone content change and inter-comparison of planetary atmospheres. The 290-ft. balloons will be launched by Winzen Research Inc., from Page, Ariz. They will carry a 1400-lb. payload, consisting of a 28-in. telescope, to a minimum altitude of 110,000 ft.

# Gemini Booster Assembly Line Readied

***Martin/Baltimore to deliver first of 15 vehicles in Jan. '63; Titan II tooling usable***

**by John F. Judge**

THE FIRST OF 15 man-rated *Gemini* Launch Vehicles will roll out of the Martin Co.'s Baltimore plant sometime in January, 1963. The huge vehicles are essentially *Titan II* boosters with extensive system redundancy and malfunction detection devices.

The basic manufacturing program for the *Gemini* boosters is integrated with the *Titan II* production schedule. About 75% of the tooling and 98% of the master gages are common to both.

Martin's Space Systems Division in Baltimore is fully utilizing the experience of the firm's Denver facility in *Titan* booster fabrication. It is not generally appreciated that almost 51% of the *Titan* hardware has always been produced at Baltimore. The Denver operation is often thought to be the sole Martin *Titan* production facility.

Manufacturing functions assigned to each facility correspond in general to similar operations on the *Titan II* missile. Martin spokesmen said the *Titan III* core will not resemble the *Gemini* booster in its manufacturing flow.

• **That extra 44/100%**—The major difference in the *Gemini* Launch Vehicle (GLV) is attributable to its manned payload. The *Titan II* is already an extremely reliable vehicle by engineering intent. To raise this formidable figure even a fraction of a percent takes an extraordinary amount of planning and effort.

There are basic differences in the missions and Martin expects to capitalize on each one—no matter how minor.

For instance, the GLV is not programed for long storage in the fueled condition as is the *Titan II* missile. Elimination of this and other weapons system requirements gives Martin engineers additional reliability-assurance approaches.

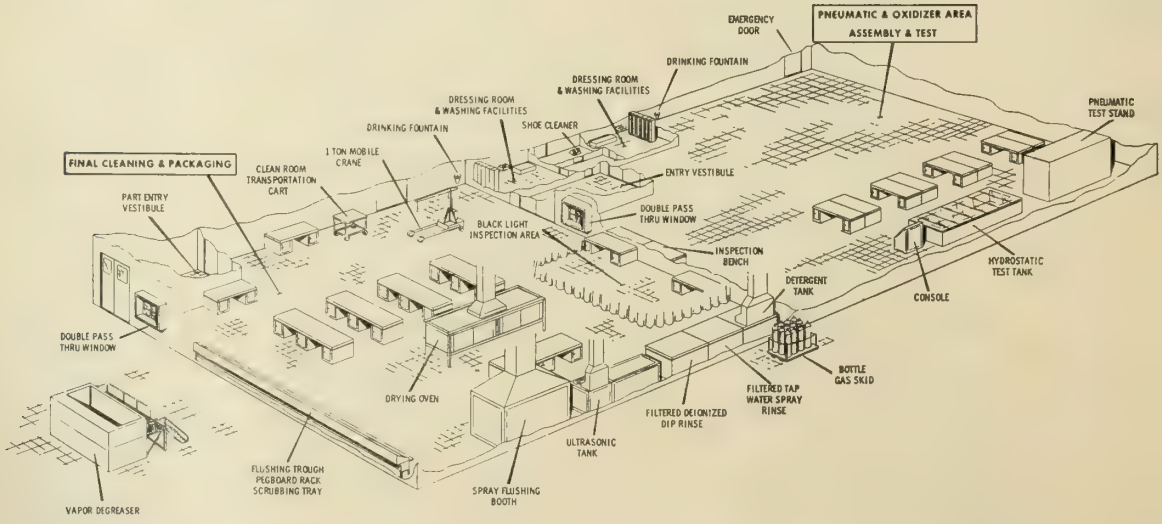
The entire work force is highly aware of the manned aspects of the program. This is promulgated on the shop floor—even to the extent of decals on the vehicle subassemblies. All personnel on the project are undergoing strong indoctrination courses on the overall program, reliability, the stringent cleanliness demands and logistics.

Depending on the particular system, certain shop people receive specified courses, some of which run as long as 180 hours. Even the most experienced production metal workers, welders, machinists and others must meet this requirement.

Martin is constructing a large "clean room" facility on the production line to handle critical parts. The personnel involved will be certified and an involved series of checks and double-checks will cover all parts run through this room.

Critical components will be identified and receive special handling, whether

*GEMINI BOOSTER contamination-control and assembly room is being constructed on the main assembly line. The facility will have all the necessary "white room" equipment and positive pressure characteristics.*



Martin-fabricated or supplied by subcontractors. The part itself, as well as any accompanying paperwork, will be marked critical by tag or decal.

So stringent is this procedure that the process plan excludes from the final vehicle any critical component exhibiting erratic behavior or transient malfunctions caused by temporary deviations during tests. Even refurbished or repaired parts must undergo an additional certification by the quality and reliability managers before gaining acceptance.

• **Manufacturing breakdown**—The basic *Gemini* area at Baltimore will handle all structural subassemblies, interstaging, skirt assembly, final assembly, installations—including engines—alignment, prevertical test, vertical test and checkout, and shipping.

Structural and system details will be fabricated in the Baltimore shop areas and delivered to the assembly area. Tanks—fuel and oxidizer—will be manufactured, tested, calibrated, cleaned and packaged at Denver. Chemical milling will also be handled at Denver. The tanks will be spliced to transtainers and shipped by air to Baltimore.

Two progressive lines will be formed in the final assembly area for component installations in both vehicle stages. Systems installations in the tank sections will be made progressively so that all sections are completed at the same time.

In the first-stage oxidizer tank assembly, the pressure switch, malfunction sensors and vaporized-oxidizer hot gas line will be attached to the forward dome. Low-level sensors will be attached to the aft dome.

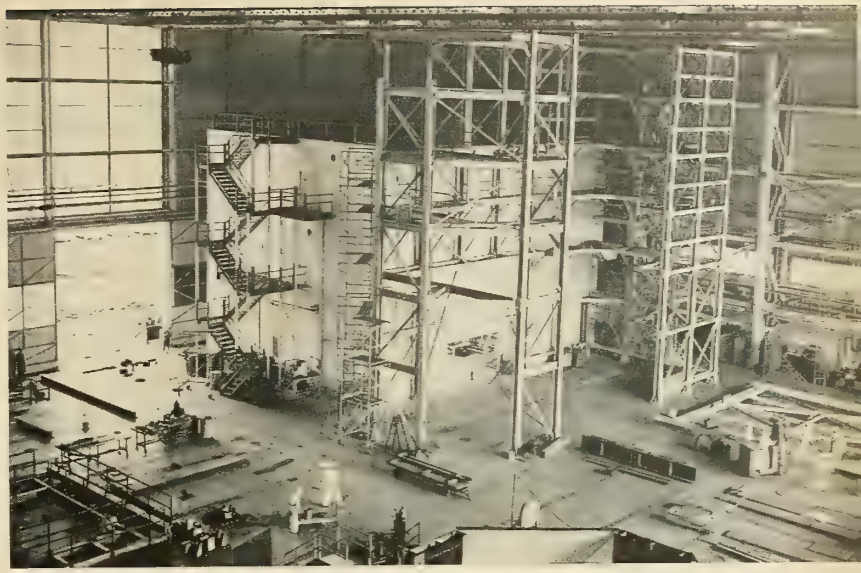
Electrical system destruct switches and MDS separation disconnects will be installed in the forward skirt and the rate gyro assembly attached to the tank manhole cover. Electrical panel assemblies and terminal strips will be fastened to the aft skirt.

The first-stage fuel tank aft skirt will support the engine interface disconnect, pad separation plugs, engine shutdown relays, instrumentation umbilical fittings, strain gages, transducers, accelerometers, amplifiers and acoustical probes.

Electrical, instrumentation and malfunction detection harnesses will be installed on both tanks and interconnected after the fuel and oxidizer tank sections are spliced.

The second-stage oxidizer tank will have its pressure switch installed on the forward dome, with the sensors and temperature probes attached to the aft dome. The command control antennas will be installed in four places.

The second-stage fuel tank will have the oxidizer feed line installed in the tank conduit. The roll-nozzle fitting will be bolted to the aft skirt together with the hydraulic system components—



*TWO FULLY INSTRUMENTED launch vehicles can be handled in this vertical test facility at Martin/Baltimore. Three-level control room in rear of test cells houses auxiliary systems functional test stands in the first level, additional ground support equipment in the second, and the third level holds the control center for compatibility tests. Test instruments on the three levels will be interconnected with each other and with both test cells. Steel "penthouse," not visible here, extends through roof of building above cells.*

reservoir-accumulator, pump, valves and interconnecting plumbing. The instrumentation system, probes, transducers, reference junction and amplifiers will also be attached to the aft skirt.

The forward skirt will hold the range safety system wave guides, power dividers, hybrid ring and junction boxes. While installations are being made in the tank section, the trusses will be wired, using wooden dummies to simulate critical electronic components, and thus eliminating the possibility of damage to these units during assembly.

Air-conditioning ducts, primacord tubing and the various electrical and electronic units will be installed on the trusses after wiring.

In each case, the tanks will not be opened until the immediate area has been cleaned and vacuumed. A "portable clean room" which fits around the vehicle in the immediate area of installation will be used to mate those components processed through the contamination-control rooms.

The engines for both stages will be shipped by Aerojet-General. Each assembly includes the engine itself, truss assemblies, accessories, malfunction detection systems sensors, wiring and tubing. Martin will prepare the engines for installation using Aerojet-supplied tooling and approved procedures.

The GLV then moves through a comprehensive pre-vertical test procedure covering the electrical, hydraulic and propulsion systems. The propulsion and pressurization systems will be leak-tested and checked for continuity of flow and function. A hydraulic system pressure check will be run; then the system will be bled and a functional operational check performed by cycling the actuators electrically.

Electrical control consoles will provide power to actuate valves and controls during the hydraulic and pneumatic servicing and testing. These units will verify that all circuits are properly interconnected and that all solenoids and controls are operative.

Following this, the stages will be painted and mated in the vertical test facility, a huge structure capable of handling two GLV's at once. Complete vehicle subsystem functional verification tests will be performed first. These include electrical, propellant and pressurization, hydraulic, flight control, range safety and tracking, ordnance, instrumentation, guidance, and malfunction and detection system tests.

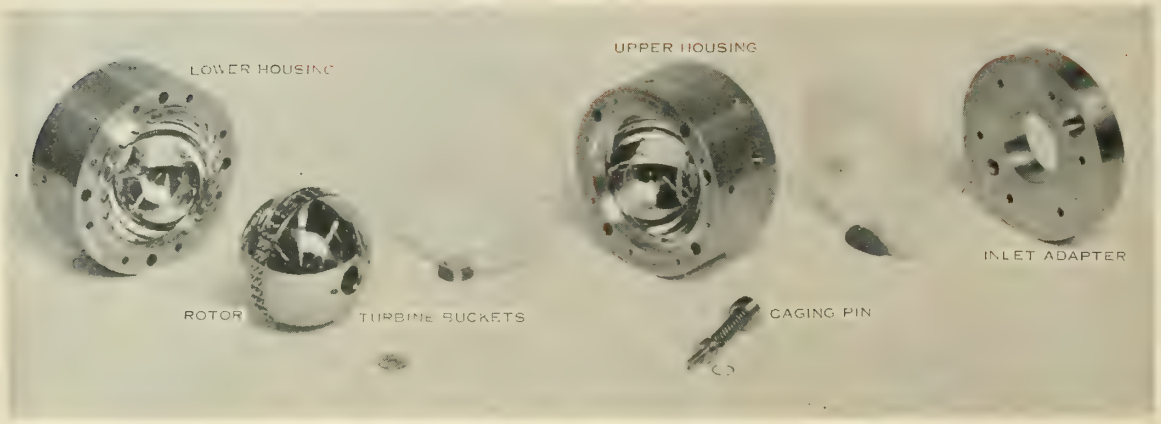
This will be topped off with a combined system acceptance test consisting of a simulated launch countdown and flight sequence with a spacecraft simulator. This final test will demonstrate that the airborne systems and allied ground equipment operate in a compatible manner, and that functions occur at the proper times and in the proper sequence.

Data will be collected through operator monitoring and manual recording. Telemetry recordings will also be made. In effect, Martin does everything short of an actual, physical launch in this vertical test facility. Next comes shipment to the Atlantic Missile Range. ⌗

# New Gyro Aimed at Tactical Missiles

*GPI's gimballess gas-bearing device claims low drift rate, high-g capability at low cost*

by Michael Getler




*HYDROGYRO disassembled to show its major components.*

LITTLE FALLS, N. J. — General Precision, Inc.'s newly formed Aerospace Group (M/R, May 7, p. 37) has come up with a proposal for a new two-axis "gimballess" rundown gryo. The move should fill a need for accurate, reliable, inexpensive gryos capable of withstanding extremely high g-loadings.

The proposed instrument uses hydrostatic pressure to run up and support the only moving part—a brass or aluminum rotor. First likely application will be in short-range tactical missiles.

Though the small and lightweight device has not yet been flight tested, engineers say laboratory tests with two prototypes showed performance characteristics far in excess of more conventional gyros requiring ball bearing support and mechanical gimballing.

• **Named "Hydrogyro"**—The device has been dubbed "Hydrogyro" by developer Bernard Parker, manager of advanced gyrodynamic research at the firm's Kearfott Div. here. Hopes for its operational use are said to be riding with Ling-Temco-Vought's proposal on *Missile B*, and also with a separate proposal made recently to Hughes Aircraft Corp. on the *TOW* missile system. Additional proposals on surface-to-air defensive missiles are expected.

Basically, here is how Hydrogyro operates:

Gas from two separate supplies enters the gyro's rotor drive inlet and gas-bearing inlet simultaneously (see drawing), though at different burning rates. For laboratory tests, cold gas was used. In an operational configuration, a hot-gas solid-propellant charge, activated by either squib or exploding bridge wire, is employed.

Under regulated pressure, gas entering the gas-bearing inlet is fed via a plenum chamber to eight hydrostatic support pads. This raises the rotor and forms the single gas bearing which, in effect, replaces the six ball bearings and two gimbal assemblies commonly found in other two-axis gyros. The flow to these pads continues throughout the gyro's operating life.

While the gas is giving the rotor support, gas entering through the rotor drive inlet also moves through a plenum and then through a series of nozzles which surround the rotor. The gas eventually impinges on the ring of turbine buckets which circle the rotor's mid-section. This action imparts spin to the rotor.

• **Rapid run-up** — According to Parker, the gas supply will accelerate the Hydrogyro rotor to 50,000 rpm in 0.1 sec. Initial angular momentum at run-up is $7 \times 10^6$ gm cm$^2$/sec.

A caging mechanism provides initial spin axis alignment, roughly fixing the position of the rotor buckets relative to inlet drive nozzles. Gas flow during the run-up phase then captures and holds the gyro so that the rotor's spin axis aligns with the average torque vector. When the rotor hits maximum turn-up speed, the gas flow stops, automatically unseating and locking out the caging pin (through a pressure tap-off point in the rotor drive inlet), effectively freeing the rotor during run-down.

A more advanced engaging mechanism using explosive actuating techniques is now under development for use with these gyros.

The gas used for turn-up, after leaving the turbine blades, is ducted along two grooves (which remain at exhaust pressure) in the inside of the casing to the exhaust ports.

After the gas to the rotor drive stops, the rotor acts as a free gyro during run-down until slowed beyond usable speeds by the viscous drag of the hydrostatic support gas.

During run-down, two pressure-sensitive pickoffs mounted in the gyro case, which, in turn, is rigidly fixed to the missile airframe, monitor position of the rotor relative to the missile about any two predetermined orthogonal axes. GPI is also developing inductive-type (E-bridge) pickoffs for use with Hydrogyro where additional accuracy requirements are imposed.

The pressure devices now included in the design are a piezoresistive-type consisting of two pairs of elements located 90° apart. The elements of each pair, 180° apart, are connected in phase opposition and define an axis of the gyro. Essentially, the pickoffs monitor pressure

between the support pad and the exhaust ports, translating pressure fluctuations into attitude variations. They require no slip rings, do not touch the rotor, and can be easily interchanged in the field.

• **Low drift rates**—In tests to determine gyro drift rates using a 2-in. dia. brass rotor and 100 psi support pressure, the unit reportedly exhibited average rates under 10 deg./hr. (0.167 deg./min.) during the first minute of operation. The tests were performed with the spin reference axis horizontal in order to subject the unit to maximum turbine torque and mass unbalance effects.

In run-down time tests (see curve) conducted with the brass rotor at 100 psi, the 25,000 rpm half-speed was reached in 40 sec., and 10,000 rpm, the area in which drift reportedly becomes significant, at about 80 secs. Run-down time, says Parker, which is a function of the viscous drag in the gap between the rotor and the case, can be altered to meet various mission requirements.

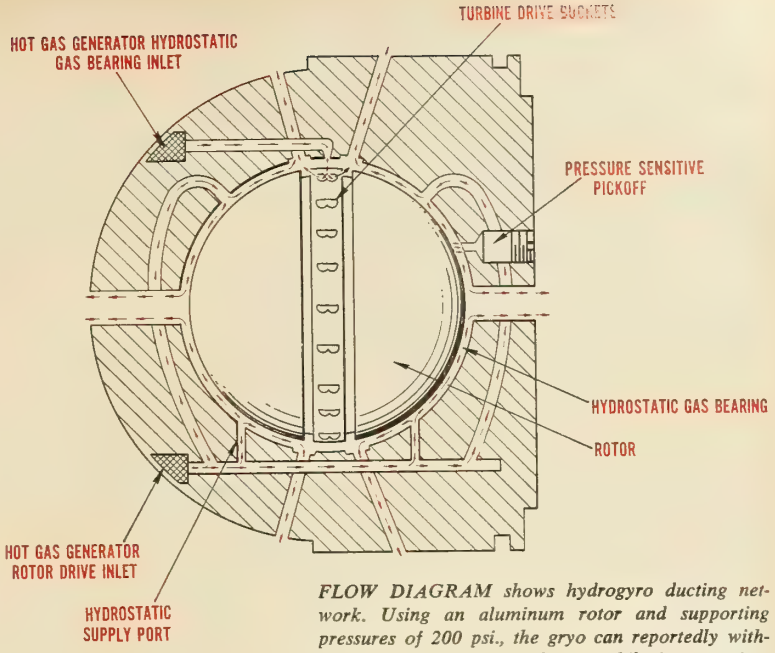
In its current design, Hydrogyro is fabricated with a 0.001-in. gap, which, in an operational configuration at 100 psi with an aluminum rotor in lieu of brass, can reportedly support loads in excess of 100 g's. By raising the support pressure to 200 psi, Parker estimates loads of 300 g's can be handled. Though use of an aluminum ball would normally decrease run-down time, Parker points out that widening the gap somewhat (requiring higher gas flow) will compensate for the lighter rotor mass and thereby extend the run-down life.

In development at GPI for two years, Parker reports that an operational unit fabricated of aluminum, including the rotor, would weigh less than 2 lbs., have a cylindrical shape 3-in. dia. and 3-in. long, and cost less than $100 in quantity.

He also feels strongly that the principles included in Hydrogyro design will be the next area of growth for short-range missile applications.

• **Mechanical advantage** — GPI's enthusiasm for the new gyro stems mostly from the advantages gained by the removal of the ball bearing and mechanical gimballing requirements. Commenting on the ability to withstand 300 g's in operation, Parker asserts "ball bearings would be hard pressed to withstand one-tenth that figure."

He also contrasts the mass stability of the gas-bearing gyro and the lack of induced vibration with the characteristic noise and vibration generations of ball bearings. "This noise is characteristically greater for the cheaper bearings and often leads to anisoelastic drifts," he says. Parker also cites the economies of the single gas bearing as opposed to the ball bearing counterparts and the lubricant deterioration problems in a radiation environment. "The gas for the hydrostatic bearing is impervious to radiation."

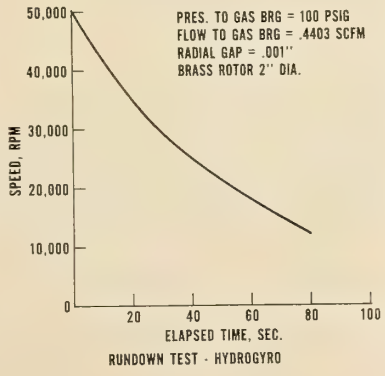



*FLOW DIAGRAM shows hydrogyro ducting network. Using an aluminum rotor and supporting pressures of 200 psi., the gryo can reportedly withstand 300-g loading conditions while in operation.*

In discussing the elimination of gimbals, Parker sees definite cost, assembly, performance and reliability advantages.

"The use of gimbals for gyros," he asserts, "requires that the spring rates along the orthogonal axis be matched for minimum drift due to $g^2$ rectification effects. Spring rate mismatch (anisoelasticity) is often the most critical item in high-g-performance gyros. One way to achieve low anisoelastic drift is to preload the gimbal bearing pairs to a close tolerance level, another quite costly operation.

"The Hydrogyro does not have gimbal rings and therefore is not subject to the associated induced g and $g^2$ drifts. The gyro rotor alone must be balanced, particularly along the spin axis. Once this is achieved, the performance due to g effects is established. As for $g^2$ effects, the anisoelasticity term is traded in for a term called anisoviscosity. This effect, similar to anisoelasticity, is a non-adjustable phenomenon, strictly a function of the gas bearing design parameters. However, anisoviscosity is generally of the order of one hundredth the anisoelastic term, and as such is negligibly small."




*CURVE shows gyro's rundown performance in laboratory tests with prototype unit.*

Another benefit Parker says accrues from the use of the gas-bearing gyro is the extremely low cross-coupling coefficient—$8 \times 10^{-6}$ deg./hr. deg./hr. The Hydrogyro design, he reports, eliminates the need for a Scorsby test, a commonly used measure of the frictional coercion between the gimbals and the resultant uncertainty torques.

The major problems in hydrostatic gas-bearing gyros are, according to Parker, the turbine torquing effects, primarily caused by unequal flow distribution. The flow conditions are a result of the geometry, fabrication and local imperfections of machining and assembly.

A proprietary technique for compensating the turbine torquing has been reportedly developed by GPI, compatible with the design philosophy of the gas bearing. This technique enables the turbine torquing direction to be altered from plus to minus with continuous control. The torque can be readily adjusted to yield low precessions due to turbine effects. ⌘

# New Emphasis on Pattern Recognition

LOS ANGELES—The relatively neglected field of pattern recognition received new emphasis with possible application in space electronics at the recent WESCON meeting here.

Discussing basic design concepts and construction techniques used in development of an advanced self-organizing image filter for pattern recognition, S. S. Viglione, head of the Electronics Laboratory at Douglas Aircraft's Astropower Inc., subsidiary, said the decision filter concept can be used to distinguish between live warheads and decoys, for accurate starfield guidance during space flights, and in sonar analysis to separate submarine echoes from those of other sources.

More sophisticated filters could be placed in *Tiros* and other weather satellites to monitor TV camera images and pinpoint storm centers as they develop, he added. The satellite would immediately transmit this information from the "space editor" to observers on Earth. It would eliminate the time-consuming effort of hand-screening thousands of weather satellite photos for storm fronts and then establishing the storm location.

The filter can automatically recognize and classify three-dimensional objects regardless of their size and orientation with respect to the viewing mechanism. Design principles were described as directly applicable to an even wider variety of problems in the broad areas of communications and data processing.

The prototype device, housed in a 3-ft.-long case, consists of a retina, a parallel-logic distributed memory system, response units and a conventional digital readout network. In the prototype, the retina contains 400 photocells and the memory consists of over 400 logic units.

Viglione said a conservative estimate is that a filter can identify 200,000 separate patterns in terms of size, orientation, and position, using the four basic shapes — cube, ellipsoid, sphere and pyramid.

The reliability approach of Von Neumann and Shannon has been incorporated in the design to permit application of "crummy" elements. A natural selection process of eliminating elements of marginal utility keeps redundancy within reasonable bounds. Full advantage has been taken of the self-organization process to minimize the engineering design task involved.

• **Discrimination of printing** — A recognition and classification scheme sensitive to common writing variations in hand-printed alpha-numeric characters was described by Seymour Spilerman of IBM's Data Systems Div. Although Spilerman did not spell out specific applications of the system other than as a computer input, the system appears to have some application as a backup system for computer input in a space vehicle. Instrument readings could be picked up by a scanning device and fed to a computer in the event that a direct sensor output failed. The system could also be used to feed a computer with instructions written by a crew member.

Classification is based upon invariances in angular change along certain segments of a line pattern. System output is a sequence of one-dimensional pattern. The most detailed statement contains a record of the slope along selected segments of the line pattern. The most condensed statement is the quantitized angular description of the pattern.

The condensed pattern is compared with a list in a computer memory to determine an initial classification sufficient to identify about one-third of the alpha-numeric characters. The remaining characters are divided into subclasses containing from two to six members. Within a sub-class, a particular member is distinguished either by the more detailed pattern statements or by additional testing.

This pattern recognition system could easily be adapted for use with a programable optical scanner. The trace would be performed by the scanner on the actual pattern with a computer directing the trace and storing the slope of each vector for later identification and utilization.

Other systems discussed included application of integral geometry to machine recognition of visual patterns (described by G. H. Ball, ITT Federal Laboratories), and a machine concept which uses time-domain signal propagation to and from memory to obtain a primitive association mechanism (described by Harry Blum, Air Force Cambridge Research Laboratories).

• **Target discrimination**—Much of the emphasis recently placed upon pattern recognition systems stems from the promise they show in warhead identification and ASW. Some scientists maintain that an advanced system can discriminate with high reliability as to whether an incoming warhead is solid or hollow—indicating, to some degree, a live warhead or a decoy. In ASW areas, pattern recognition and logic systems are already playing a major role—with such success that very few people are now willing to talk about them. ■

## Energy Conversion Buildup

LOS ANGELES—Major new business for the electronics industry should result from new techniques involving direct conversion of energy from light and heat, Dr. Elmer W. Engstrom, RCA president, told WESCON. He said advent of these techniques should be ranked on a level with development of the electron tube and the semiconductor.

Dr. Engstrom estimated R&D activity in energy conversion will approach the $100 million mark this year.

"This is in contrast to virtually nothing five years ago," he said, adding that "there is every reason to believe the industry can equal in the next 10 years the technical and business growth record of the past half century."

Annual achievement award presented by the western region of the Institute of Radio Engineers at WESCON went this year to Dr. Hewitt D. Crane, senior research engineer, Stanford Research Institute, for his work as originator of the so-called MAD (multi-aperture devices) in design of computer memories and logic systems and as inventor of the neuristor, a new kind of logic element.

## Report on Mariner II

(Continued from page 16)

*Mariner* is carrying a microwave radiometer and an infrared radiometer to gather information about the planet's temperature and atmosphere. The other experiments, which began working Aug. 29, include a magnetometer to measure its magnetic field, a charged particle detector, a cosmic dust detector and a solar plasma detector.

• **Microwave radiometer**—This experiment should help to resolve two vital questions about Venus: what is the atmosphere like, and what is the temperature of the surface?

As the *Mariner* flies past Venus, the microwave radiometer will scan its surface to detect electromagnetic radiation at two wave lengths, 13.5 and 19 millimeters. In the electromagnetic spectrum 12.5 mm is the location of a microwave water absorption band. If there is water vapor above certain minimal concentration in the atmosphere, it will be possible to detect it.

The 19mm wave length, however, is not affected by water vapor, and should be capable of "seeing" through the atmosphere to the surface.

Scientists studying the results of this experiment will be able to determine whether water vapor exists in the Venusian atmosphere by noting the difference in temperatures obtained from measurements at the two wave lengths.

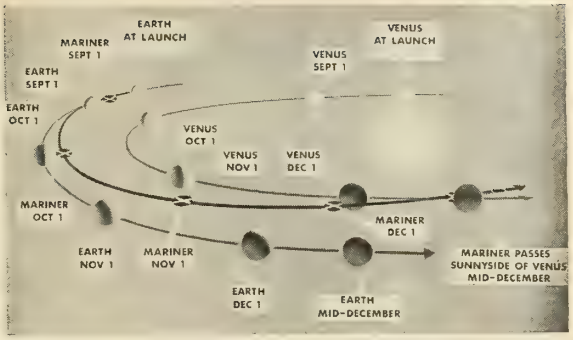
The microwave radiometer weighs 23.8 lbs. and consumes 3.5 watts of power.

• **Infrared radiometer**—This is a companion experiment to the microwave radiometer. As the *Mariner* flies past Venus, simultaneous measurements from the two experiments will enable scientists to get a better idea of the temperature and atmospheric conditions of the planet.

The infrared experiment operates in the 8 to 9 and the 10 to 10.8 micron wave length regions of the electromagnetic spectrum.

Measurements from Earth in these two wave lengths indicate temperatures below zero.

The close approach of *Mariner* to Venus may enable scientists to measure some of the finer details of the atmosphere. This will primarily involve finding out if there are any "breaks" in the cloud cover of Venus, and if so, the amount of heat that escapes through them into space. For many years some astronomers have occasionally been able to see some kind of markings on Venus's cloud cover that change with no apparent regularity. The lack of regularity in these markings has left their nature in doubt.




*NASA chart shows plan for Mariner II's 180-million-mile trip past Venus.*

• **Magnetometer**—This experiment is designed to measure the strength and direction of interplanetary and Venusian magnetic fields.

Many scientists believe that the magnetic field of a planet is due to a fluid motion in its interior. If such a Venusian field exists, it could be detected as *Mariner* approached the planet. This would depend, of course, on the strength of the field and the distance of *Mariner* at encounter. Also, the trajectory of *Mariner* will permit the measurement of interplanetary magnetic fields and any variation with respect to time and distance from the Sun.

*Mariner's* measurement of interplanetary magnetic fields will be combined with simultaneous measurement from Earth to help scientists understand something about the interrelationships of these fields.

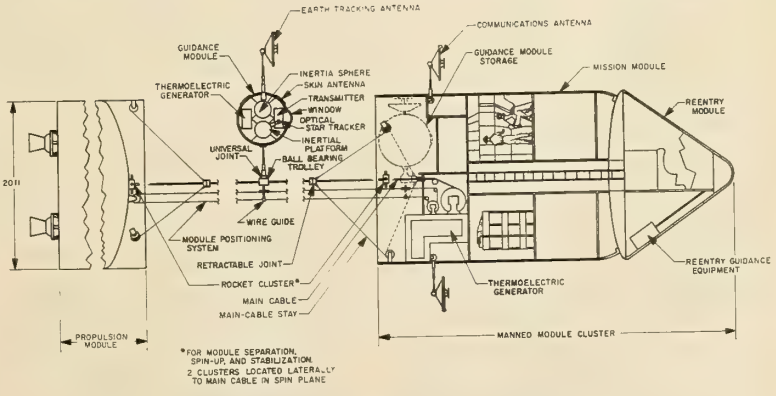
Moreover, by investigating the magnitude of any Venusian field it may be possible to draw some conclusion about the interior of the planet, as well as about planetary radiation belts, magnetic storms, and aurorae.

The magnetometer is a three-axis fluxgate type. It weighs 4.7 lbs. and comsumes six watts of power.

• **High-energy radiation experiment**—This consists of an ionization chamber and a group of three Geiger-Mueller tubes. Together they will measure the number and intensity of energetic particles in interplanetary space and near Venus.

These particles are primarily cosmic rays, which are made up of protons (the nuclei of hydrogen atoms), alpha particles (the nuclei of helium atoms), the nuclei of heavier atoms, and electrons.

*(For a detailed report on the Mariner spacecraft, see M/R, July 23, p. 32.)*




## Spinning Spacecraft Proposed

*ARTIST'S DRAWING illustrates JPL scientist Eugene Lally's concept of spacecraft configuration to overcome effects of prolonged weightlessness in manned space flights. Lally advocates the spinning of a spacecraft to provide artificial gravity. During flight, the cabin or mission module in which the crew would ride is separated from the propulsion module (larger vehicle) by an extended cable. Small rockets would then spin the two elements around a common center to create artificial gravity. By adjusting the length of the cable, the crew could control various "comfort factors" of artificial gravity. A major disadvantage of the concept, which would be used for flights to Venus and Mars, would be the difficulty of performing navigational functions as the entire craft rotated.*

# The Case Against Concurrency —And Its Opposite



**by Joseph V. Charyk**

*Under Secretary of the Air Force*

ONLY EIGHT YEARS AGO a serious effort in ballistic missile technology was launched. From the management side, a new concept was introduced. The combination of technical skills required for this undertaking was such that the use of a system contractor in the classical sense was deemed unsuitable and the systems engineering contractor and associate contractors technical management scheme was born.

Because of the vital importance of the program, time was critical. Streamlined approval channels were established; broad authority was given directly to the program director; contractual actions were initiated in the interests of expediting the activation of elements of the program, without serious consideration to performance incentives or penalties for non-performance and to the contractual provisions therefor; multiple approaches were initiated on most critical items; maximum concurrency was the keyword. The missiles in the operational inventory today, and those soon to enter the inventory and capable of performance well beyond the initial goals, are adequate testimonials that the race to beat the clock was won.

• **"Virus planted"**—In this case, we failed to move out on the ballistic missile program with sufficient vigor at an early enough date. Faced with the Soviet missile progress, maximum speed in our program was of the essence. The cost, of course, in dollars, was much higher than it would have been for a lower-concurrency, longer-paced program. In this case, there is no doubt in my mind that there was no other choice. But therein was planted the virus of what I might call the maximum concurrency disease, and it does not necessarily follow that the particular management approach used and the concept of maximum concurrency, are the unquestionable answers to system development problems. Quite the contrary. Unfortunately we have in our military space program at least one or two instances where a similar philosophy has left us with high expenditures and no operational capability. A complete and expensive concurrency total system development plan for a speculative, and perhaps mystic, military operational requirement is not the road to national strength in this important field—it could well be the road to dissipated resources, abortive programs, loss of national prestige and most serious of all, if uncontrolled—a threat to national survival.

And now, so that I may be equally unpopular with another school of thought, let me say a few words against the "sequentialists." This is the "orderly-minded" faction that favors a complete series approach and a full demonstration of all of the elements of all the subsystems before proceeding on a step-by-step basis through all the other phases of a program. In my opinion, this is a sure road to the guaranteed obsolescence of the weapon systems which may finally emerge. With the pace of modern technology, and with the criticality of superior military capability to national security, to be second may well be suicidal.

• **Combination needed**—The key then is a combination of simple, but difficult, things—a mature judgment as to the areas of critical importance, a willingness to take calculated development risks, a solid determination and will to terminate promptly, or reorient programs where new factors have changed the tenets on which the program was launched, an assertive and prompt response to new and challenging possibilities, a willingness by industry and government to experiment with new contracting and management methods with premiums for performance and penalties for malperformance.

• **Good example**—I have spoken on this theme before and I am delighted that now we are beginning to get some early indicators of what can, in fact, be done. An interesting case is the *Agena-D*, a program to seek a standard upper stage vehicle for many of our space programs in the interests of achieving a respectable and vital reliability figure, a feature which was not a noteworthy characteristic of its early versions.

The initial estimate in the early fall of 1961 was that the best possible schedule would result in an initial vehicle delivery in November of 1962, with initial launch in January of 1963. This was on the basis of a high-level effort, using procedures and techniques similar to those in effect for most of our programs. This was deemed to be completely unsatisfactory and a Special Group was activated to investigate ways and means by which the program could be expedited. Amazingly enough, after a thorough scrubbing of the program, a new schedule was evolved calling for initial vehicle delivery in April 1962 and initial launch in June 1962, a telescoping by about a factor of two.

The management and organizational arrangements called for far fewer people, simple reporting procedures, and an incentive type contract based on schedules, performance and cost. Both of these dates were met and the flights to date of the new vehicles have been successful.

In this case I am confident that streamlined procedures, with streamlined management and attendant responsibilities, accomplished with far fewer people, far fewer dollars and far less time, what could have been accomplished under more normal rules of program development. In this case, however, the job was well specified initially and changes were not permitted. In an advanced development activity, however, and even assuming that the mistake of premature system development is not made, complete definition "by definition" is impossible and different rules must apply.

• **Far to go**—I believe we have made much progress in attacking some of the basic problems to which I have alluded, but between industry and government we still have a long way to go.

I am greatly concerned that much of our best technical and management talent is engaged in program acquisition rather than program execution. Our contracting methods, and their emphasis on the impressive paper proposal, have encouraged this unfortunate trend. Its reversal is not accomplished overnight but I believe progress is being made. With the development of suitable yardsticks, and the resultant measurement of performance in other programs, a more quantitative rating can be given to a particular contractor's record and this, in turn, used as a major determinant in selection on a new program. The contractor's record of retention of key personnel on going programs, or his early rejuggling to try for new business at the expense of the acquired programs, provides an important barometer as to his sense of obligation and dedication to the best fulfillment of his commitments. In cases where performance degrades seriously, we have in the past, and will apply more broadly and stringently in the future, bars to invitations to him to compete for new business. The country needs results, not promises; it needs fulfillment of performance milestones, not the filling and filing of massive reams of proposal material; it needs the competent manager, not the soothing syrup dispenser in Washington. More and more do we need the simple answer and not the ingenious all-function mousetrap; we need the clever solution, not the brute force answer; we need the original idea, not the bigger and better version of the old; we need realism, not fantasy; we need the identification of the critical elements, not the barrage approach. Our ability to put these simple maxims into practice will be a major factor in determining our place in the military technology role; there is no prize for second place but there is a penalty of the highest type.

*(Condensed from speech on Aug. 15 at the Seventh Annual Symposium on Ballistic Missile and Space Technology, Colorado Springs, Colo.)*

# The Industry Week

## New Industry Facilities

Minneapolis-Honeywell Regulator Co.'s electro-optical division is moving from Los Angeles to Boston. The move is expected to be completed in October. To house the unit, M-H will lease an added 20,000 sq. ft. in downtown Boston as well as part of the space now devoted to its nine other facilities in the area. M-H already has a Boston-and-vicinity employment roster of more than 4000, with a payroll of over $26 million. . . . *The Kearfott Division of General Precision Aerospace will develop, fabricate and install a celestial-inertial test complex at Holloman Air Force Base, N.M., under a recently awarded million-dollar-plus contract from the Air Force Missile Development Center. The complex will give Holloman a standard test facility for celestial inertial guidance systems and will augment the existing inertial guidance test complex.* . . . Washington Technological Associates, Inc., Rockville, Md., consolidated production and manufacturing facilities in a new 40,000-sq.-ft. building in Rockville. The new building will double production space for part of the company's activities, including expanded production of specialized printed circuit boards, signal stimulators and decommutators and general-purpose data processing equipment. . . . *Raytheon Service Co. and Lindgren-Swinerton-California are constructing a new missile launch complex at the Point Arguello, Calif., portion of the Pacific Missile Range. Initial funding of $206,000 has been received for work on the new launch facility under a Lockheed Missiles & Space Co. contract. The joint venture between the two companies will involve installation and checkout of all electrical, RF and aerospace ground support equipment supplied by Lockheed to prepare the launch complex for operation.* . . . The Electronics and Avionics Division of the Emerson Electric Manufacturing Co. has begun a half-million-dollar expansion program for production and research facilities devoted to thermostatic thermal-barrier materials. Expansion was prompted by increasing use of the company's heat blocking compounds for aerospace activities. The new facilities will be located at the company's main plant in St. Louis.

## International News Briefs

The recently merged Lear Siegler, Inc., announced that it will move its international operations from Geneva to Paris and that it will expand its overseas activities. The company is now constructing a new 60,000-sq.-ft. plant at Munich, Germany. . . . *English Electric Aviation, a member of the British Aircraft Corp., will close down its guided weapons plant at Luton, England, over the next six months. More than a thousand employees will lose positions as a result of the closing, brought about by cancellation of the Blue Water nuclear ground-to-ground missile project. After the closing, missile work will be concentrated at the Stevenage, England, plant.* . . . The Sperry Gyroscope Co., Ltd., says it now contributes almost half Britain's total exports of aeronautical instruments as compared with less than 20% three years ago. More than 30 countries now receive Sperry Aero equipment, the company said.

## News of Mergers and Acquisitions

Martin Marietta Corp. has announced the sale of its adhesives and resins division to two other firms. Sale price is reportedly more than $7 million, and the transaction will be made final early in October. The company described the sale as being consistent with its present policy of shedding parts of its operation that are not directly related to its major activities. The division being sold has headquarters and research units in Seattle, Wash., and other facilities in Portland, Ore., Richmond, Calif., and Newark, Ohio, as well as in Canada. . . . *Electronic and Missile Facilities, Inc., contractors, have bought 80% of Hegeman-Harris Co., Inc., a New York construction firm. The purchased firm will become a subsidiary of the buyer.* . . . Sierra-Schroeder Controls, Glendale, Calif., and its entire work-in-progress inventory have been bought for approximately $350,000 by the Cal-Val Research and Development Corp., Woodland Hills, Calif. Sierra-Schroeder will retain its present management as a subsidiary of the purchasing firm, and all its equipment and accessories will be acquired through a lease-purchase arrangement.

## New Names in the Industry

Taylor Fibre Corporation has changed its name to Taylor Corporation to reflect the diversification of the firm's product line. In addition to vulcanized fibre, the company's products include laminated and high-temperature reinforced plastics, filament-wound structures, and die stamped circuits (made by Dytronics, Inc., a subsidiary). . . . *Texas Instruments, Inc., Dallas, consolidated its components and transistor products divisions under a single name: Semiconductor/Components Division. The firm feels that combining the divisions will enable it to better realize the potentials of its products in present and future markets.*

## Value Engineering Savings

Litton Systems reports savings of more than $1 million as a direct result of value engineering seminars held recently. One seminar team reduced the number of parts on a flange from eight to one before releasing it to production. . . . *The Value Engineering Division of Lockheed-California Co. at Burbank has waged a cost prevention campaign that it says has paid off in savings of over $8 million so far this year.*

# contracts and procurements

## AWARDS

### AIR FORCE

$23,700,000—**General Dynamics Corp., Astronautics Div.,** San Diego, Calif., for installation and checkout of *Atlas* missiles.

$14,250,000—**Thiokol Chemical Corp., Wasatch Div.,** Brigham City, Utah, for production of the first-stage *Minuteman* motor.

$14,000,000—**Radio Corp. of America,** New York City, for operation and maintenance of the Ballistic Missile Early Warning System at Thule, Greenland; Clear, Alaska; and Riverton, N.J.

$9,210,843—**General Electric Co.,** New York City, for systems management and integration for work during 1962 on an air weapons control system (supplemental contract). Work to be done at Syracuse, N.Y.

$4,600,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for production of long-lead-time items and ground support equipment for *Skybolt* missiles (supplemental contract).

$4,160,000—**North American Aviation Corp.,** Downey, Calif., for research and development on *Minuteman* missile and guidance control.

$3,600,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for continued work on space vehicles (supplemental contract).

$2,600,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on *Agena* space vehicles for use by NASA. Work to be done at Sunnyvale, Calif.

$2,045,000—**General Electric Co.,** Syracuse, N.Y., for continued work on a classified communications project.

$2,000,000—**Sylvania Electric Products, Inc.,** Mountain View, Calif., for research, development and production of security equipment for *Minuteman* missile bases.

$1,600,000—**General Precision, Inc.,** for continued work on the guidance system of the *Mobile Mid-Range Ballistic Missile*. Work to be done at Little Falls, N.J.

$1,080,000—**North American Aviation, Inc.,** Downey, Calif., for work on the *GAM-77 Hound Dog* missile program (supplemental contract).

$500,000—**Lear Siegler, Inc., Instrument Div.,** Grand Rapids, Mich., for analysis, design and testing of a control-display system for advanced manned air and space vehicles.

### ARMY

$1,285,182—**U.S. Steel Corp., Consolidated Western Steel Div.,** Los Angeles, for 538 shells for nozzle assemblies on the *Little John* rocket. Work to be done at Baywood, Calif.

**Rocket Research Corp.,** Seattle, for design of a new internal combustion engine accessory that would be driven by rocket propellants (undisclosed amount).

### NAVY

$41,000,000—**North American Aviation, Inc., Autonetics Div.,** Downey, Calif., for 39 MK-11 Mod 2 ships inertial navigation systems for *Polaris* submarines.

### NASA

$630,000—**Ryan Aeronautical Co.,** San Diego, Calif., for explosive forming of aluminum segments for fuel compartment bulkheads in the *Saturn C-5* rocket.

### INDUSTRY

$1,000,000—**Cessna Aircraft Co.,** Wichita, Kan., from the **Boeing Co.,** for additional *Minuteman* missile transporter-erector units.

$850,000—**Moog Servocontrols, Inc.,** East Aurora, N.Y., from **Douglas Aircraft Co.,** for steering controls to be used on the *S-IV* stage of the *Saturn* rocket.

$481,464—**Electronic Systems Div., of Antenna Systems, Inc.,** Maitland, Fla., from **Selenia SPA,** Rome, Italy, for tracking antennas and control systems.

$400,000—**Radiation, Inc.,** Orlando, Fla., from **AC Spark Plug,** for additional airborne pulse code modulation (PCM) telemetry systems for the *Titan* program.

$206,000—**Raytheon Service Co. and Lindgren-Swinerton-California,** from **Lockheed Missiles and Space Co.,** for work on a new missile launch complex at Point Arguello, Calif.

$130,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, from the **Boeing Co.,** for high-temperature thermocouple wire to be used for temperature measurements aboard the *X-20 (Dyna-Soar)* spaceship.

$127,000—**Cosmodyne Corp.,** Hawthorne, Calif., from **Boeing Co.,** for controls to maintain constant pressures in the environmental oxygen tanks on the *X-20 (Dyna-Soar)* spaceship.

$76,000—**Melpar, Inc., Western Engineering Laboratories,** Northridge, Calif., from **North American Aviation, Inc.,** for development of a portable computer for use in detecting and locating point of impact of weapons or missiles.

**Melpar, Inc.,** Falls Church, Va., from **North American Aviation's Space and Information Systems Div.,** for research and development of a beacon antenna system for NASA's *Apollo* spacecraft (undisclosed amount).

**Lear Siegler, Inc.'s Instrument Div.,** Grand Rapids, Mich., from **McDonnell Aircraft Corp.,** for design and production of a new simplified flight attitude instrument for use aboard the two-man *Gemini* orbiting space vehicle (undisclosed amount).

**Swedlow, Inc.,** Los Angeles, from **Hercules Powder Co., Inc.,** for production of high-temperature insulative materials for advanced missile applications (undisclosed amount).

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

U.S. Navy Dept.
Bureau of Ships
Washington 25, D.C.

The Bureau of Ships under RFP 687B-28846(S) is soliciting a proposal from Communications Electronics, Inc., Bethesda, Md., and Westrex Corp., Div. of Litton Systems, New York 19, N.Y., for the manufacture of special control units for a classified system. Both of these firms have had experience with the system. Such experience is essential in order to furnish the control units by the required dates. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firms.

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Bureau of Naval Weapons
Washington, D.C.

The Bureau of Naval Weapons contemplates entering competitive negotiations with the firms listed below to furnish *Sidewinder 1A* guidance and control sections: (1) General Electric Co., French Road, Utica, N.Y. (2) Philco Corp., 4700 Wissahickon Ave., Philadelphia, Pa. An industrial security clearance may be required. RFP is not available. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting should contact the above firms direct referencing CN7860-62. BuWeps Synopsis No. 39-63.

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Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Requests for IFB and RFP should be sent within 10 days after publication of this synopsis. Copies will be furnished to the extent available on a first received first served basis. Fabrication, assembly and testing of micro-meteoroid satellite *S-55* series. This procurement will require the services of 7 professional engineers and 25 technicians of a highly specialized nature to perform fabrication, assembly, installation and testing of micrometeoroid satellite *S-55D* series. Contractor's employees will perform work under the direct supervision of the government, using government-owned equipment and facilities at Langley Research Center, Hampton, Va. A time and materials type of contract is contemplated for this procurement. Contract period will be 16 months for 3 engineers and 4 technicians and 12 months for 4 engineers and 21 technicians. Phone requests should be directed to Hampton, Va., Phone 622-7961, Ext. 4881—RFP L-2586—RFP Due Date 9-13-62.

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Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Services and materials necessary to design, construct and calibrate 30 heat flow transducers to meet the performance requirements of NASA Spec. No. L-2636 and complete delivery shall be accomplished within 5 months after award of contract. Proopsals are requested on a negotiated fixed price basis. The proposals will be evaluated on the basis of 3 major factors stated in the request for proposal—Job—IFB L-2636—RFP Due Date 9-24-62.

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Aeronautical Systems Div.
Wright-Patterson AFB, Ohio

Investigate thermoelectric materials and analyze trade-offs for long time utilization in structural heat protection systems applicable to hypervelocity flight vehicles. To design, construct and evaluate demonstration models incorporating materials exhibiting the most optimum characteristics in the temperature range of 2000 degrees F to 3000 degrees F—RFP 33-657 63-5084—Attn. ASKPDC Phone: Clearwater 3-6111, Ext. 35156 or 40233. RFP must be requested by 9-5-62.

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National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

FM-FM Telemetering ground support equipment—RFP 26737—RFP due date 9-14-62. Design and manufacture of 22, five-kilowatt AM satellite interrogation transmitters. For the design and manufacture of five-kilowatt AM satellite interrogation transmitters—RFP 26055—RFP due date 10-5-62.

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General Support Div.
Directorate of Procurement & Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

Continued research and development effort on *Redeye* missile system. Work will be performed at General Dynamics/Pomona, Calif. during the period 10-15-62 through 9-30-63. Non-availability of drawings and specifications, duplication of initial investment in special tooling and facilities, and the requirement for technical know-how precludes award to other than the above contractor. All inquiries relative to subcontracting should be referred to General Dynamics/Pomona, Calif.

# HERE IS A PARTIAL LISTING OF CONTENTS

**UNITED STATES GOVERNMENT:**
Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

**INDUSTRIAL SECTION:**
Detailed listings of major missile/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

**COMPANY REPRESENTATIVES SECTION:**
Listing company representatives stationed in Washington and in most strategic missile/space areas.

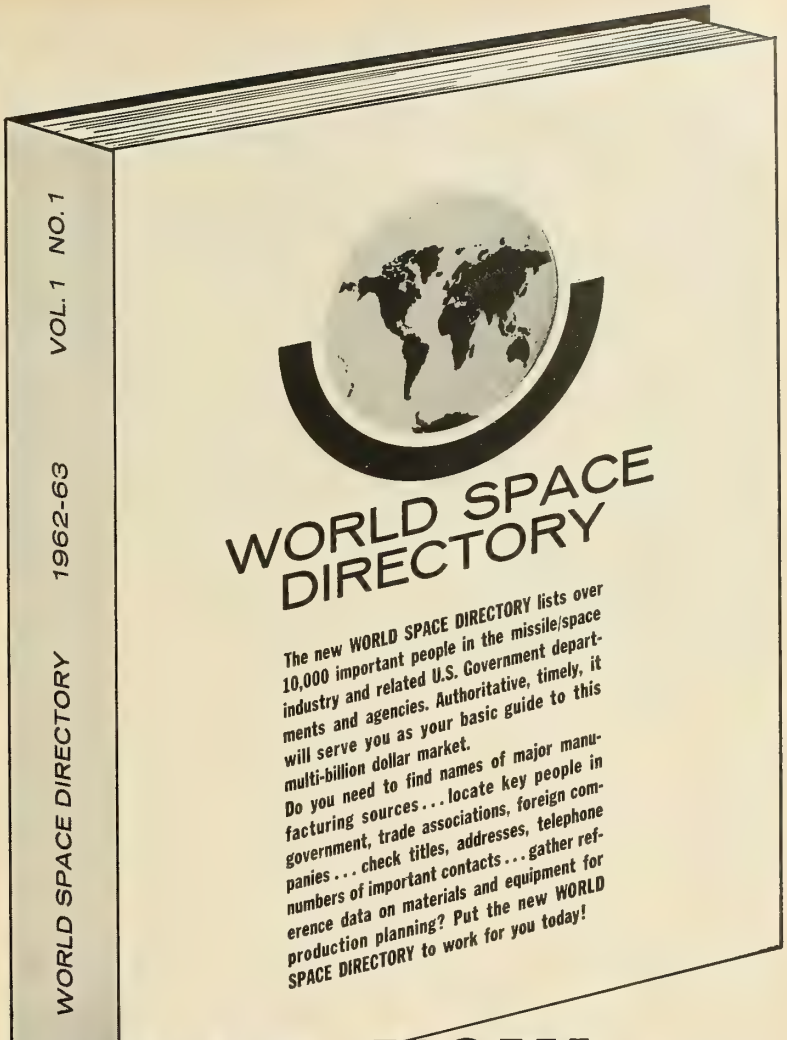
**INTERNATIONAL SECTION:**
Covers all countries with missile/space activities, plus all NATO member nations.

**PERSONNEL INDEX:**
A cross-referenced index of over 10,000 key personnel in industry and government.

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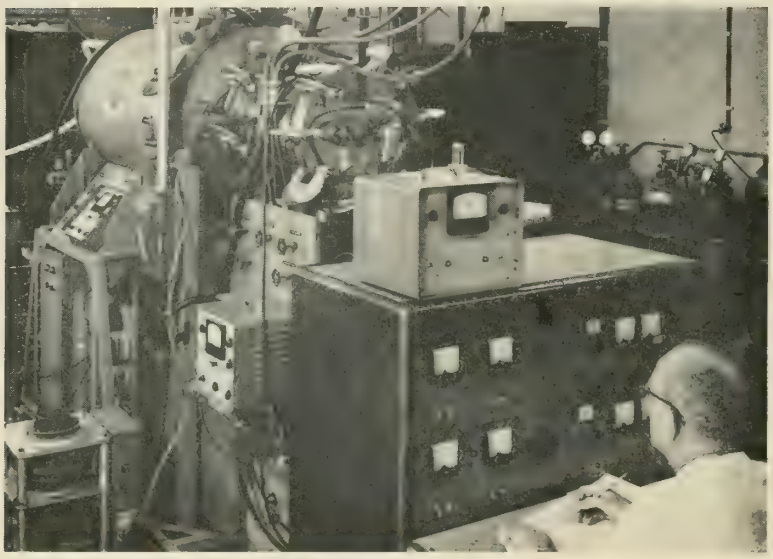
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## New Product of the Week:

## Space Simulation Chamber

A SPACE simulation chamber capable of reaching pressures even lower than those experienced in interplanetary space is available from National Research Corp.

The NRC Extreme High Vacuum (XHV) chamber has reached pressures as low as $10^{-15}$ torr. The lower limits of the NRC chamber's operating range are not known. There are no instruments yet capable of measuring lower than $10^{-15}$ torr.

The entire system is 7 ft. long and 3 ft. wide. The working region is about half this size. The design principle of the system can be used for the construction of larger facilities operating in this pressure range. The chamber is equipped for cryogenic cooling using gaseous helium (−442°F) and liquid nitrogen (−322°F).

The pumping system uses NRC oil diffusion pumps with cold caps and liquid nitrogen-cooled baffles which eliminate backstreaming. Additional pumping capacity is provided by the cryogenic temperatures of surfaces that make it possible to condense gases given off by materials and devices being tested.

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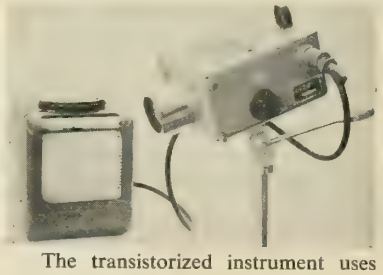
## Compact Sideband Filter

A small upper sideband filter for stringent communications requirements has been developed by Systems Inc. Designed for applications in single-sideband military communications equipment, the Model USB 1750-3.2 has a center frequency of 1.75 mc and a bandwidth of 3.2 kc, with a minimum of 30 db carrier rejection and greater than 60 db stopband rejection.

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## Radiometer-Strip Recorder

Williamson Development Co., Inc., is marketing a combination of portable 18-lb. 5-in. strip chart recorder and industrial radiometer (low-temperature radiation pyrometer), which permits rapid set-up and change of location, and records surface temperatures without contact.



The transistorized instrument uses the null balance principle for maximum stability, accuracy, and freedom from ambient temperature effects. Operational temperature ranges from 100°F to 1200°F.

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## Multi-Channel Data Systems

The Dacord line of multi-channel, magnetic tape recording systems, developed by Electro-Medi-Dyne, Inc., offers 2 to 16 channel systems featuring an integral monitoring scope for each channel.

The systems are available in either fixed or variable bandwidths ranging from DC to 4KC and tape speeds of 3¾, 7½, and 15 ips.

Dacord's integral monitoring scope for each channel permits selectable monitoring of signals and adjustment of input signal without running the tape. The scope also features calibrated sweep speeds from 100 microseconds to 10 seconds.

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## Pushbutton Switches

Round display assemblies for Series 2 lighted pushbutton switches are being marketed by Minneapolis-Honeywell's Micro Switch Division. Control models are available with momentary or alternate (push-on, push-off) switch action and with optional magnetic detent coils. Altogether, there are 20 different switching options, assuring circuit and power versatility.

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## Environmental Test Chamber

The Enviratron Co. is marketing Enviratrol Model UCH-300 which stimulates temperature from —300°F to 350°F with liquid nitrogen and electric heaters. Higher temperatures to 500°F is available, as well as humidity 20% to 95% between 35° and 180°F

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## High-Vacuum Deposition

Two high-vacuum deposition systems, ERINVAC Model RRC-124 and ERINVAC Model RRC-126 are available from Royal Research Corp. These systems, developed specifically for ultrapure thin-film production applications, include lower ultimate pressures of better than $5 \times 10^{-8}$ torr, faster coating cycles, and automatic/sequenced, fail-safe operation that eliminates losses due to operator error.

The systems utilize stainless steel in all high-vacuum components between the high-speed diffusion pumps (720 liter/second for Model RRC-124 and 1440 liter/second for Model RRC-126) and the stainless steel, 20-in. O.D. base plates.

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## Variable Filter Unit

A solid-state, constant-percentage bandwidth-variable filter with a frequency range from 8 to 2500 cps has been developed by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell.




Designated the Type 1-159 variable filter, the instrument features a 3% bandwidth at the 3 db point, and an attenuation of 55 db one octave either side of the tuned frequency.

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# new literature

TRANSISTOR REPLACEMENT GUIDE —A radio transistor replacement guide from the General Electric Co. cross-references the company's 8 basic "universal" replacement transistors with 1218 types of transistors commonly used.

Circle No. 200 on Subscriber Service Card

DELAY LINE DESIGN DATA — A 10-page technical booklet describing how to design a delay line that can be delivered in 24 hours is available from Allen Avionics, Inc. It includes charts and tables as an aid in determining size and performance.

Circle No. 201 on Subscriber Service Card

WIDE-BAND D-C AMPLIFIER — Complete specifications for Elcor's Model DCA-50C wide-band D-C amplifier are now available in Bulletin No. 43-562. The unit is applicable for laboratory or other needing signal amplification over a very wide band with low phase or amplitude distortion. Driven by a single-phase input signal, the DCA-50C will provide two output signals in complementary phase, the principal output being in phase with the input, with a gain of 10 for each phase and a push-pull signal amplitude of 100 volts peak-to-peak. Non-linearity is less than 2%.

Circle No. 202 on Subscriber Service Card

REAGENT CONTROL — A two-page reprint titled "X-ray Controlled Reagent Feeding in Flotation", giving engineering and operating information on a new quality control system, is available from Philips Electronic Instruments. Figures are given for average assays on a 55-shift experimental run and a table shows how reagent consumption was modified. Two charts indicate change of zinc content in mill feed during operating periods of moderate variation as well as during periods of large, rapid variation.

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INTEGRATED RF COMPONENTS— Applied Research's "Integrated RF Component" brochure describes some of the most significant improvements and additions to the product line which includes broadband, narrow band and solid-state amplifiers and converters; passive and active multicouplers; bandpass and rejection filters; broadband, solid-state passive frequency multipliers; and fixed attenuators, terminations and impedance matching transformers.

Circle No. 204 on Subscriber Service Card

ENVIRONMENTAL TEST CHAMBERS — A 1962 56-page catalog of environmental test chambers available from Conrad, Inc. includes various Conrad products such as cloud and pour oil test chambers for petroleum products, low temperature chests, hyper environment chambers, and chambers adaptable to vibration exciters.

Circle No. 205 on Subscriber Service Card

MICROWAVE CAPABILITIES — A brochure from Neico Microwave Co., describes design/engineering, test & inspection, assembly, machine shop, and other departments involved in the production of microwave components. Among the types of microwave components produced by Neico are: wavemeters, filters, mixers, directional couplers, rotary joints, ferrite devices, waveguide switches, and other precisely-fabricated components.

Circle No. 206 on Subscriber Service Card

FEED-THROUGH CAPACITORS — Technical data on duct-type feed-through capacitors, subminiature-size units for military, aircraft, automotive, industrial electric and electronic applications, is available from Aerovox. Capicitors listed in this bulletin are rated for use in circuits up to 10 amperes continuous duty. Voltage ratings available are 100 through 600 VDC and 125 VAC operation at frequencies up to 400 cps. Sizes and typical attenuation curves in a 50 ohm system also are shown.

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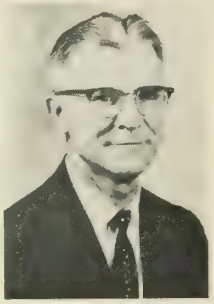
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# names in the news


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MYERS

**W. J. Martin:** Appointed director of reliability for General Dynamics/Convair, San Diego, Calif.

**Richard S. Bowers:** Named executive vice president of Ortronix, Inc., Orlando, Fla.

**Paul R. Breen:** Appointed manager of the Radio Development Dept. and acting manager of the Digital Development Dept., Government Products Div., Adler Electronics, Inc., New Rochelle, N. Y.

**Carter L. Burgess:** Elected chairman of the board and chief executive officer of American Machine & Foundry Co., New York, N. Y. **Rodney C. Gott** elected president and **Frank P. Downey** elected executive vice president.

**Bennett W. Wright:** Appointed manager of PneumoDynamics Corp.'s Advanced Systems Development Div., El Segundo, Calif.

**Eugene J. Fink:** Former assistant to the manager of special studies in market analysis, cost control and management recommendations at Bethlehem Steel Co., Baltimore, announces the formation of Universal Management Services Corp., Baltimore.

**Dr. Charles H. Stockman:** Named technical director, B. F. Goodrich Aerospace and Defense Products Div., B. F. Goodrich Co., Akron, Ohio.

**Lt. Gen. Donald N. Yates (USAF ret.):** Former commander of the Air Force Missile Test Center at Cape Canaveral, elected vice president of Raytheon Co. and general manager of the Missile and Space Div., Lexington, Mass.

**J. William Jones:** Elected president of General Dynamics Corp.'s Electric Boat Div., Groton, Conn., and a vice president of the parent company.

**C. E. Reid:** Elected vice president in charge of manufacturing at Republic Aviation Corp., Farmingdale, N. Y. **Murray Berkow** elected vice president, aerospace systems and services.

**J. L. Atwood:** Named chairman of North American Aviation, Inc., Los Angeles.

**Brig. Gen. Charles M. Baer (USA ret.):** Named senior technical military representative-Europe for Sylvania Electronic Systems, Paris.

**Angus Macdonald:** Appointed manager of defense program development at the Chicago Center, Military Electronics Div., Motorola, Inc.

**Nevin Palley:** Former executive vice president of Curtiss-Wright Corp., appointed executive director of technical operations for Martin Co.'s Denver division.

**Dr. Norman H. Enenstein:** Named manager of the newly created systems division, Hughes Aircraft Co. ground systems group, Fullerton, Calif.

**John E. Mungenast:** Appointed manager of market and distributor development for General Electric Co.'s Rectifier Components Dept., Auburn, N. Y.

**Franklin Finke:** Named corporate executive vice president-finance and assistant to the president of Operations Research Inc., Silver Spring, Md.

**W. Dean Wallace:** Appointed operations manager of the Rochester Instrument Plant, American Standard Controls Div., Rochester, N. Y.

**Richard H. Briebel:** Promoted to president of ITT Kellogg Telecommunications Div., Chicago. **George A. Banino** promoted to president of the ITT Kellogg Communications Systems Div.

**F. J. Dunleavy:** Appointed executive assistant to the president of International Telephone & Telegraph Corp., New York City.

**Charles F. Myers:** Named vice president, marketing, of the Albert & J. M. Anderson Manufacturing Co., Boston.

**Samuel J. Davy:** Named vice president of engineering of National Co., Inc., Malden, Mass.

**Dr. Henry L. Pope:** Named manager of development planning for Thompson Ramo Wooldridge, Inc.'s RW Div., Los Angeles.

**W. F. Springgate:** Appointed manager of research and engineering for the New Bedford, Mass., division of Aerovox Corp. **Karl Moeglich** appointed research consultant.

**R. B. Bonney:** Elected executive vice president of Electronic Engineering Co. of Calif., Santa Ana.

**Dr. Ronald S. Johnson:** Appointed director of plans/economics for the Douglas Missile and Space Systems Div., Santa Monica, Calif.

**David J. Hodges:** Appointed manager of voltage-turntable magnetron engineering at General Electric's Power Tube Dept., Schenectady, N. Y.

**William F. Sauers:** Appointed vice president of North American Aviation's Management Engineering and Controls Div. in the Autonetics Div., Downey, Calif.

**Edward L. Montgomery:** Appointed assistant director of space and weapon systems for Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif.

**James V. Bitner, Jr.:** Appointed vice president of the Instrument Div., Lear Siegler, Inc., Grand Rapids, Mich. **Russell W. Richardson** appointed vice president-contracts. **Johannes N. Thiry** named vice president-engineering and **Robert A. Gollhardt** named vice president-manufacturing.

**John R. Smythe:** Promoted to director of engineering of Exide Industrial Div. of the Electric Storage Battery Co., Philadelphia.

**Joseph M. Williams:** Appointed director of research and development of the Bunting Brass and Bronze Co., Toledo, Ohio.

**Bernard Rider:** Appointed director of research and development for the Maryland Div. of Litton Systems, Inc., College Park, Md.

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# when and where

## SEPTEMBER

**International Symposium on Information Theory, Institute of Radio Engineers,** Brussels, Belgium, Sept. 3-7.

**National Advanced Technology Management Conference,** Opera House, Seattle World's Fair grounds, Seattle, Sept. 4-7.

**Association for Computing Machinery, National Conference and 17th Annual Meeting,** Hotel Syracuse and the War Memorial Auditorium, Syracuse, N.Y., Sept. 4-7.

**Symposium on Measurement of Thermal Radiation Properties of Solids, sponsored by Aeronautical Systems Div., USAF; National Bureau of Standards, and NASA,** Biltmore Hotel, Dayton, Ohio, Sept. 5-7.

**Seminar on Automatic Checkout Techniques, sponsored by Aeronautical Systems Div., USAF, and Battelle Memorial Institute,** Battelle Memorial Institute, Columbus, Ohio, Sept. 5-7.

**Thirteenth Annual Reliability Engineering and Management Institute,** University of Connecticut, Storrs, Sept. 9-21.

**Fourth National Conference on Applied Meteorology, American Meteorological Society,** Hampton, Va., Sept. 10-14.

**Tenth Annual Engineering Management Conference, IRE,** Hotel Roosevelt, New Orleans, Sept. 13-14.

**Hydrofoil & Air Cushion Vehicles National Meeting, sponsored by the IAS and Navy Bureau of Ships,** Shoreham Hotel, Washington, D. C., Sept. 16-18.

**Air Force Association's Sixteenth National Convention and Aerospace Panorama,** Nellis AFB Gunnery Range, Las Vegas, Nev., Sept. 18-23.

**Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences,** Hotel Commodore, New York City, Sept. 19-20.

**Eleventh Annual Industrial Electronics Symposium, sponsored by IRE, American Institute of Electrical Engineers and Instrument Society of America,** Sheraton Hotel, Chicago, Sept. 19-20.

**IRE Conference on Communications,** Roosevelt Hotel, Cedar Rapids, Iowa, Sept. 21-22.

**National Power Conference (ASMW-AIEE),** Lord Baltimore Hotel, Baltimore, Sept. 24-26.

**Space Power Systems Conference, ARS,** Miramar Hotel, Santa Monica, Calif., Sept. 25-28.

**Symposium on the Physics of Failure in Electronics, sponsored by Rome Air Development Center, USAF Systems Command and Armour Research Foundation,** Illinois Institute of Technology, Chicago, Sept. 26-27.

**Symposium on Dynamic Behavior of Materials, sponsored by the University of New Mexico and Rocky Mt. District of American Society for Testing and Materials,** University of New Mexico, Albuquerque, Sept. 27-28.

**Fourth Pacific Area National Meeting of the American Society for Testing Materials,** Statler Hilton Hotel, Los Angeles, Sept. 30-Oct. 5.

## OCTOBER

**National Communications Symposium, Institute of Radio Engineers,** Hotel Utica, Utica, N.Y., Oct. 1-3.

**Third Symposium on Advanced Propulsion Concepts, sponsored by General Electric Co. and AFOSR,** Sheraton Gibson Hotel, Cincinnati, Oct. 2-4.

**National Symposium on Space Electronics and Telemetry, IRE,** Fontainebleau Hotel, Miami Beach, Fla., Oct. 2-4.

**10th Annual Human Engineering Institute, sponsored by Dunlap & Associates,** Stamford, Conn., Oct. 2-5.

**18th Annual National Electronics Conference and Exhibition, sponsored by AIE, IRE, Illinois Institute of Technology, Northwestern University and University of Illinois,** McCormick Place, Chicago, Oct. 8-10.

**National Aeronautic & Space Engineering & Manufacturing Meeting & Display, Society of Automotive Engineers,** The Ambassador Hotel, Los Angeles, Oct. 8-12.

**Conference on Ions in Flames and Rocket Exhaust,** El Mirador Hotel, Palm Springs, Calif., Oct. 10-12.

**20th Annual Aerospace Electronics Exposition/Report, Aerospace Electrical Society,** Pan Pacific Auditorium, Los Angeles, Oct. 10-12.

**International Symposium on Space Phenomena and Measurement, sponsored by NASA and AEC,** Statler Hilton Hotel, Detroit, Oct. 15-18.


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# Watchdogs on the Hill

THIS WEEK, a subcommittee of the Congressional Joint Committee on Atomic Energy opens hearings into the three-way dispute over management of the *SPUR-SNAP 50* nuclear space power program. The committee hopes to force some agreement on the program among officials of the Atomic Energy Commission, the Air Force and the National Aeronautics and Space Administration.

Chairman Melvin Price (D-Ill.) says the delay in the nuclear space power program threatened by the jurisdictional dispute is the main reason for the probe, which also will explore the *Rover* and *Pluto* projects.

Senior Editor William Beller of MISSILES AND ROCKETS was instrumental in bringing the dispute to Congressional attention. He first uncovered the situation in an article last winter (M/R, Feb. 19, p. 12). Although three Congressional committees were assured following this that the problem was being solved, the issues have not been settled to this date.

On July 23, we called editorially for Congressional action to force clarification of the management structure of the program. This was prompted by industry disclosure that the disagreement was beginning to hamper research and development.

Reaction was swift:

- Three weeks ago, the JAEC scheduled the hearings which open Wednesday.
- At the same time, the House Appropriations Committee announced that $3.4 million was being slashed from the AEC budget in this field, pending solution of the dispute.

Top officials of the three agencies still are protesting to the Hill that the problem is not yet a problem because nuclear space power is in such an early research stage. This does not jibe with what we are told by government personnel assigned to the *SNAP-50* and *SPUR* programs and by industry sources. Rep. Price has this to say:

"I've heard the basic research excuse so long that it doesn't impress me."

A study of AEC testimony before the House Appropriations Committee makes it plain why the committee took the drastic step of cutting the AEC space power budget.

The AEC's general manager, Gen. A. R. Luedecke, testified: "Our lack of understanding with NASA at the moment is on timing with respect to the undertaking of development of the other components of the system and the organization under which this would be done."

Dr. Frank K. Pittman, director of AEC's division of reactor development, told the committee: "The only point of disagreement is who has the responsibility for developing the rotating equipment that can convert the power of the reactor into electrical current. That is the point that is not yet resolved."

The two officials thus could not even agree on what the disagreement was about! Between them, however, the two men managed to convince the committee that there was no agreement on 1) who was going to build what, 2) when it would be built and 3) how the program would be managed. The AEC grab for a bigger role in space power stood clearly revealed.

This was sufficient justification for the committee to cut the funding, until objectives could be more clearly defined. Even the JAEC, which normally could be expected to side with AEC in this situation, agrees. Rep. Price calls the action quite proper in light of the AEC "indecision" about the program.

The Price subcommittee has invited AEC chairman Seaborg, NASA Administrator Webb and Defense Secretary McNamara to testify. Also invited are representatives of industrial firms and national laboratories involved in the program.

"We are trying to find out why they are having difficulty in establishing direction in these programs," Rep. Price says. "Once they do this, the programs will move along better."

We are in complete agreement. The nuclear space power program needs unified direction. It is too important to be the object of a triple tug-of-war. Best available estimates indicate direct cost of *SPUR-SNAP 50* system development will total more than $300 million.

A program of this size needs clear definition of its management structure and its objectives. No one expects the three agencies to have all the scientific answers in a research program such as this. But the answers will be found much more swiftly if the program is properly directed.

THE ACTION—or inaction—of the three agencies in attempting to cover up the dispute is not in the national interest. When top-level meetings failed to bring agreement, a decision apparently was made to sweep the whole mess under the carpet, despite assurances to Congress that the problem would be solved. Each of the agencies seemingly would prefer to further entrench itself in the field before a decision is forced.

They are not to be allowed this luxury.

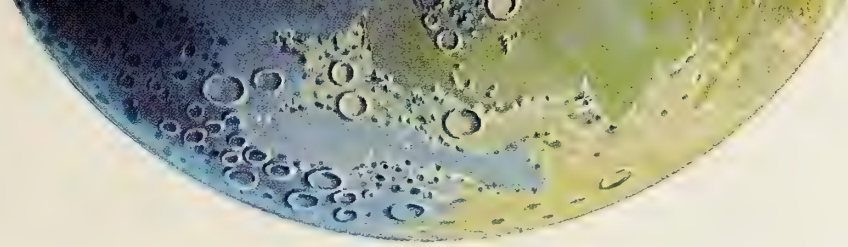
"We insist on a decision," Rep. Price says. "There is no excuse not to decide now."

We are pleased to have had a part in bringing the dispute to public attention. But we are more pleased to find Rep. Price and the JAEC, backed by the House Appropriations Committee, fulfilling their watchdog role in the finest Congressional tradition.

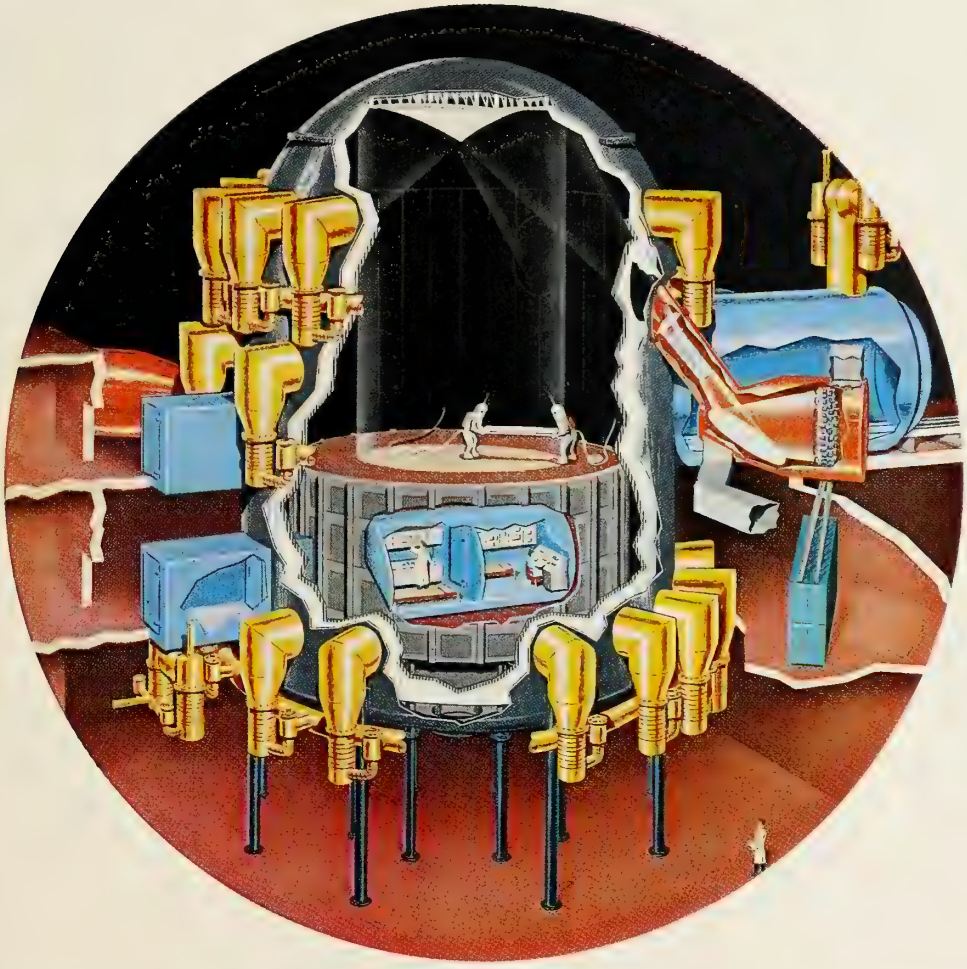
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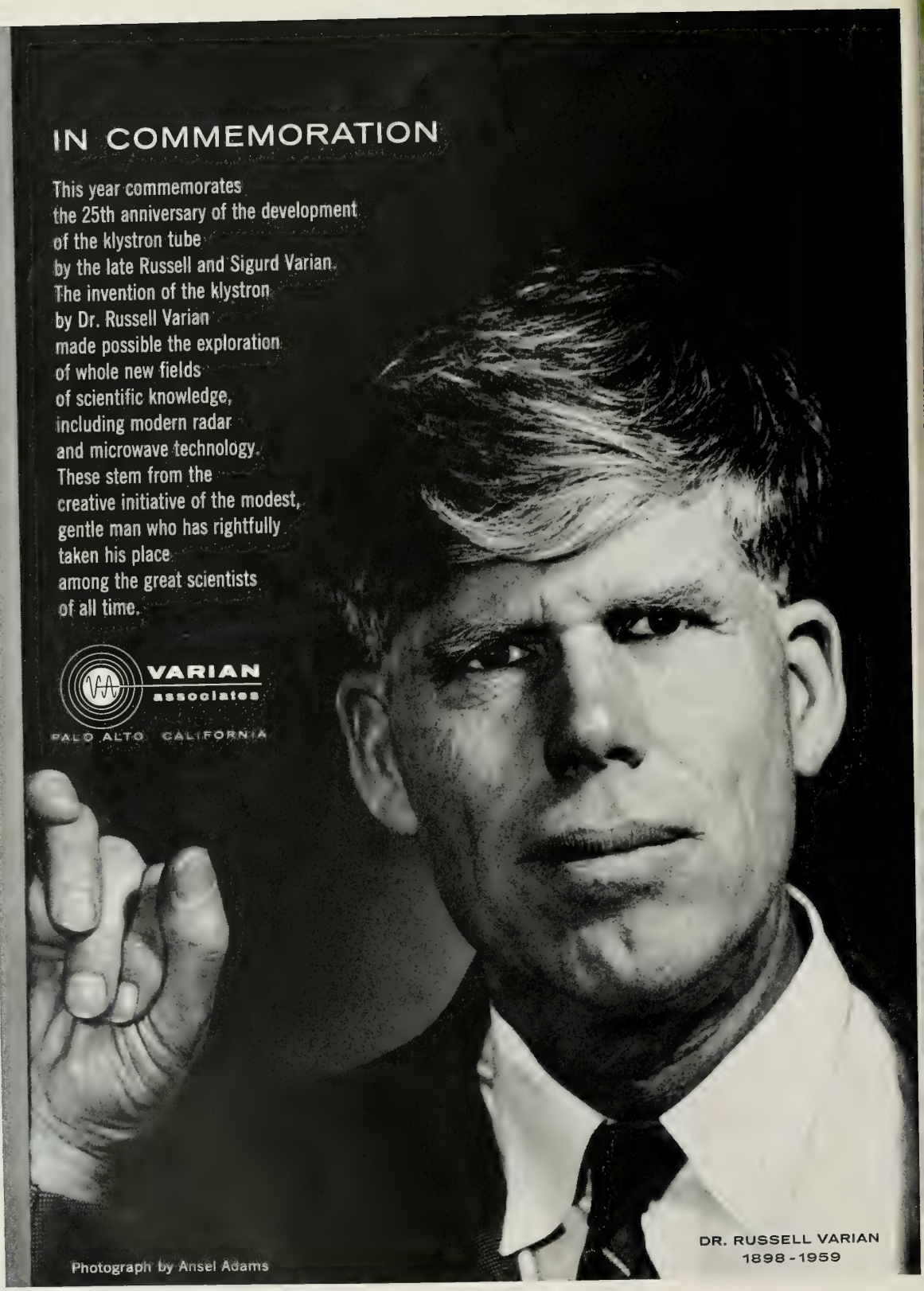
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# missiles and rockets

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ATION



# Beech helps space vehicles get better mileage by turning "hot" fuel into icy slush

## *Slush hydrogen experiment shows vital facet of Beech's comprehensive systems management capability*

At the heart of this experiment at Beech's Boulder, Colorado, space center are three double-walled vacuum jars, each inside the other. Inside the inner jar is liquid hydrogen, while the center jar contains liquid helium. The outer jar is filled with liquid nitrogen. The idea is to further reduce hydrogen temperature until it turns to icy slush.

The purpose of this experiment is to explore the feasibility of reducing hydrogen volume in order to increase space vehicle fuel loads without increasing tankage size or weight.

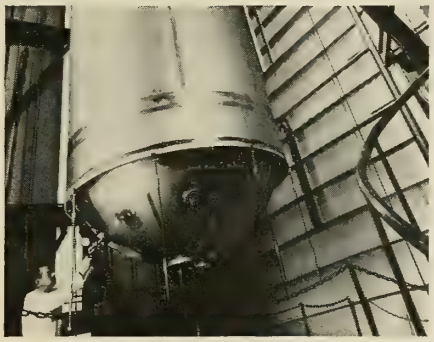
Applied research projects like this are common at Beech. In the past they have included valuable work on cryogenic problems, space environment, and countless other projects that have measurably advanced the state of the art.

Basic research and development is but one of an ever-expanding group of Beech space-age capabilities. Within the last year alone, the size and function of Beech space facilities has more than doubled. This constantly expanding capability complex, coupled with a highly trained and experienced staff, makes Beech a natural choice for systems management projects. Besides the experiment shown here . . .

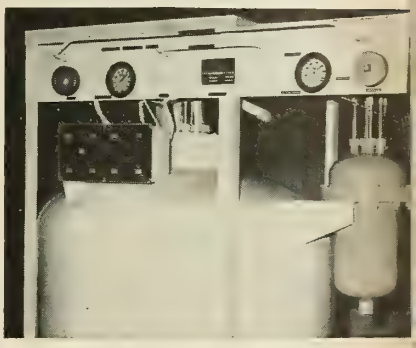
## Other Beech Capabilities In Systems Management Include:



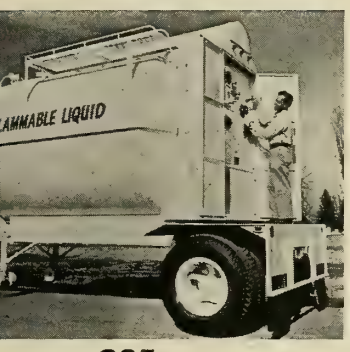
***R & D...***



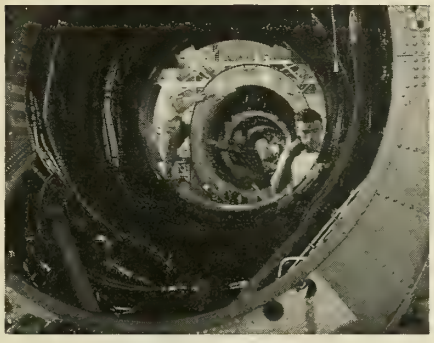
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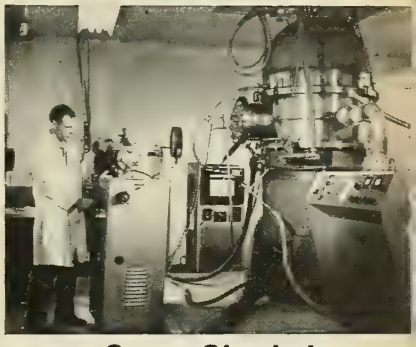
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***GSE...***



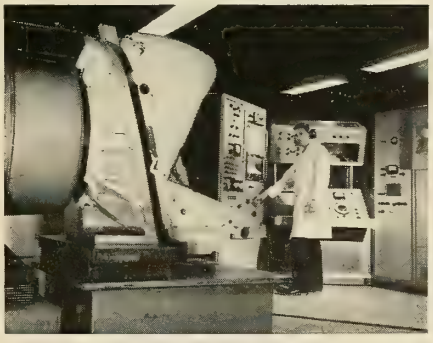
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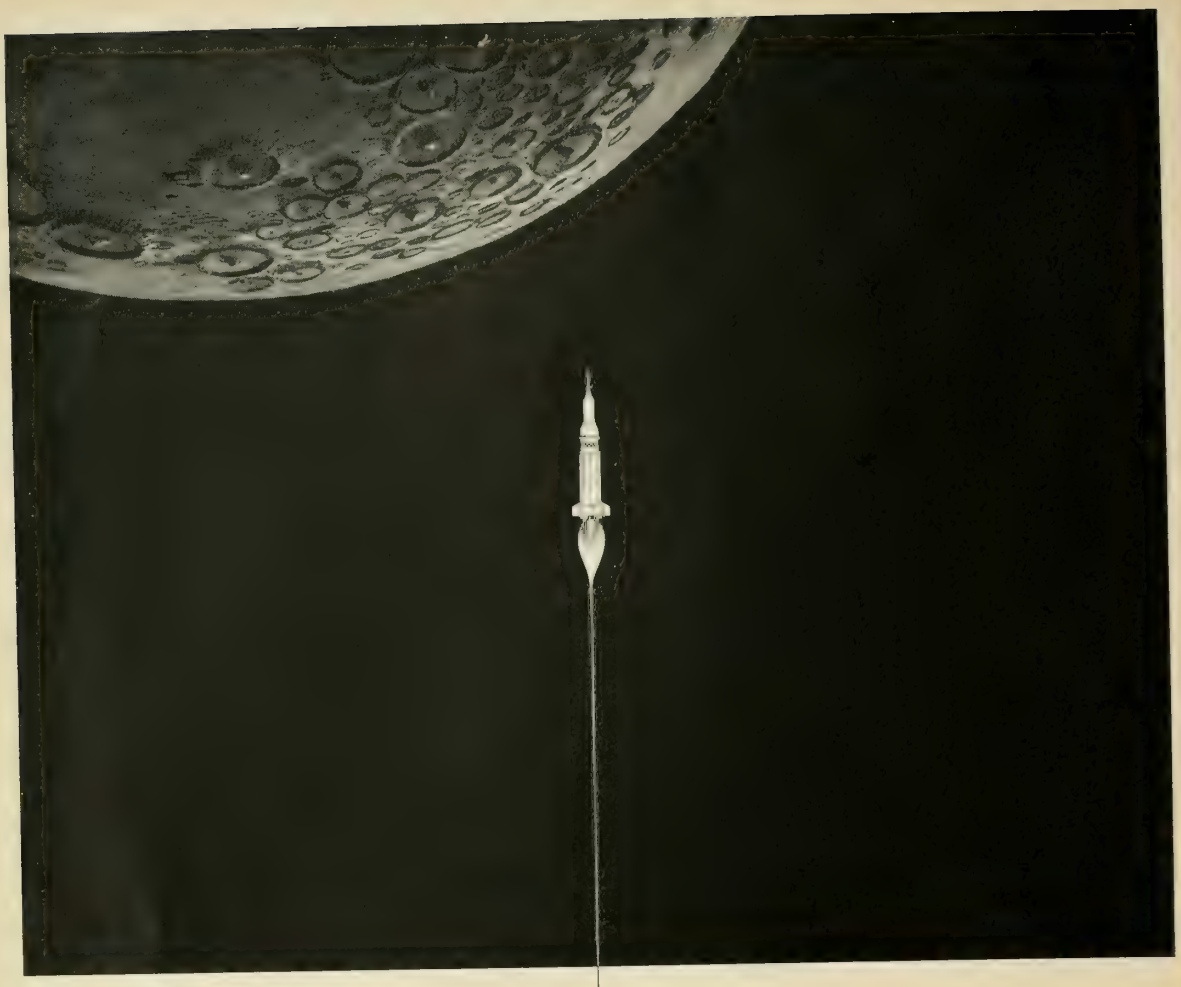
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# missiles and rockets

Volume 11, Number 11 September 10, 1962

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## THE COVER



*Trials of the Douglas Skybolt mated to Britain's Vulcan jet bomber are to begin at the Air Proving Ground at Eglin AFB, Fla., early next year. For a special report on APG's activities in the missile/space field, see p. 36.*

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# memo from the publisher

GROWTH is the key word around MISSILES AND ROCKETS these days and I thought you might be interested in a few of the things that have been taking place.

In the editorial department, we are pleased to announce that Russell E. Hawkes, one of the nation's top missile/space writers has joined our California news bureau. Russ worked both in industry and in the trade paper publishing field. His most recent assignment was in the West Coast bureau of Aviation Week where he earned a reputation as an accurate and knowledgeable writer during six and one half years covering industry developments. Russ received his B.S. in Journalism from the University of Wisconsin, after completing high school in Park Ridge, Ill. Russ has a commercial pilot's license with over 1400 hours total time and is an avid sail plane enthusiast. He is 33 years old, married and has three children.

ASSOCIATE EDITOR Frank McGuire returns this week on a full time basis, after a year's leave of absence on a Columbia University Science Writing Fellowship and a subsequent three-month tour of Europe. He will be covering the Capitol Hill beat. Frank is an outstanding journalist and we are happy to have him back.

CIRCULATION continues its upward spiral. We will have over 40,000 paid subscribers by the end of September—a gain of 5,000 new subscribers since the first of the year. From what you tell us, our complete systems coverage seems to be what you want in a trade paper these days. A number of recent industry surveys of trade paper reading habits reveal that MISSILES AND ROCKETS is among the best read technical publications in the missile/space industry.

Gains also are being registered in our advertising department. Although page totals for other aerospace publications are down considerably from 1961, MISSILES AND ROCKETS has shown a substantial 50-page ad gain through August—another indication of industry acceptance.

DON'T MISS the special report on Space Electronics in next week's MISSILES AND ROCKETS. Compiled by the entire editorial staff under the direction of Senior Editor Charles LaFond, the study covers trends in R&D in each of the major electronics fields that will answer the expected needs of NASA and the military through 1970. Market estimates will be detailed over the same period. The survey and the technical articles will cover guidance and control, telemetry, communications, detection and tracking, power sources, checkout, and instrumentation. In addition, a procurement guide will be included which will show who the major government buyers of hardware and services are and where the important procurement areas are for space electronics.

NEW DEPARTMENTS. As most of you are aware, new product development in the space electronics field is increasing rapidly. To better serve those of you in the Electronic Systems area, we are starting, effective October 1, a new section in the magazine called NEW SPACE ELECTRONICS PRODUCTS. This feature will be included in the first issue of every month thereafter. I think you will find it a very useful department.

Our editorial department already is at work on our Second Annual NASA issue to be published November 26. This is scheduled to be our biggest effort of the year in order to bring you up to date on the many changes that have taken place in NASA in recent months. Final procurement and development decisions on such programs as *Aeros, Advanced Relay, Nova Super Booster, Advanced SYNCOM* and *Lunar Logistics Vehicle* will be made in the next few months. It is our intention to dig into these areas to give you as complete a rundown on their status as possible. We will also be reporting on the many changes brought about by the recent decision to use Lunar Orbit Rendezvous for the first Manned Lunar Landing. If NASA's activities are important to you, watch for the November 26 issue.

JAMES W. CLAAR

# letters

## Nuclear Hearings

*To the Editor:*

I want to tell you how impressed I was with your articles in the Feb. 19 and July 23 issues of M/R concerning the lack of cooperation and resulting lack of progress in the AEC, NASA and Air Force programs for developing nuclear power systems for space.

For some time I have been most concerned with the inability of these agencies to work together. As Chairman of the Subcommittee on Research, Development and Radiation of the Joint Committee on Atomic Energy, I have called a series of public and executive session hearings at which I have requested responsible officials of the AEC, NASA and the Defense Department, as well as representatives from industry, to testify.

I want you to know that my decision to hold these hearings at this time resulted in part from some of the facts uncovered by you and set forth in your articles.

Melvin Price, Chairman
Subcommittee on Research,
Development and Radiation
Joint Committee on Atomic Energy
Congress of the United States
Washington

## Military Space

*To the Editor:*

I'll make this short. I agree with your Aug. 27 editorial ("Playing with Blocks"), we do need another Billy Mitchell. This time on the Navy's *Polaris* submarine. Consider the feasibility of such an expensive weapon system. Consider that the anti-weapon of this weapon system will make it obsolete before the full fleet is developed. Consider the money saved and put to use on military satellites if we took the Navy's "toy" away.

Thomas D. Ross
Inglewood, Calif.

## Addle-pated Scientists

*To the Editor:*

I was very pleased to read your editorial "The Big Knife" (M/R, Aug. 20). The article covered many points that have been burning in my mind.

Your reference to "addle-pated scientists and politicians" covers the complete cause of our sad position in the present status of the space race. This country, I feel, lost its reservoir of pioneer individuals required for this great venture in the far beyond. In place of pioneers we have addle-pated scientists, paunchy and conniving politicians, and money-hungry executives. Assuredly each of these has his place in the scheme of things, but decidedly not controlling our very destiny.

Joseph C. Szempias
Toledo, Ohio


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To support these activities the Division's 23 million dollar facilities, located just north of metropolitan Boston, has recently added a new space research laboratory to simulate conditions encountered by vehicles returning to earth after lunar and interplanetary missions.

Featuring facilities such as an MHD shock tube and molecular beam shock tunnel to accelerate gases to 60,000 feet per second, the new addition extends the Division's capability to offer scientific and technical personnel the proper atmosphere and equipment to carry out assigned and future programs.

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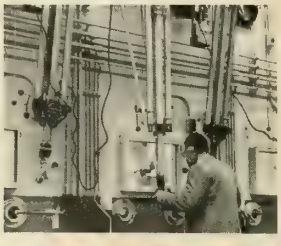



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# The Countdown

## WASHINGTON

### AF Satellites Damaged by Radiation

The new nuclear radiation belt has damaged some Air Force secret satellites. On future shots, additional protection is to be provided for solar cells against the electron damage caused by the radiation belt.

### Scout to Launch Operational Transit

Significant weight reductions in the operational *Transit* have enabled the Navy to switch from the *Thor-Able-Star* to a less expensive *Scout* booster. The four-satellite navigational system is to be placed in orbit next month.

### Funding Changes Require DOD Approval

Control over the RDT&E efforts of the three services has been extended to require specific approval by the Secretary of Defense for all funding changes of more than $2 million for some 340 identified activities or major development projects. A similar limitation is being developed for military construction and procurement accounts.

### SPRINT Definitely Not a Zeus

Contrary to initial reports, SPRINT—a highly classified missile project designed to overcome DOD objections to *Nike-Zeus*—is not a follow-on *Zeus*. The exact nature of the system has not been revealed but it will be able to handle significantly more targets than *Zeus*.

### And Here's Another

The new Aerospace Corp. office at White Sands Missile Range, which has a staff of less than 10, is working with the Air Force in the flight test program of an anti-ICBM vehicle. No details are available.

### Where Will the Lines be Drawn?

The roles of General Electric and AT&T's Bellcom subsidiary in the Lunar Landing Program are strictly advisory and analytic, according to officials of the two firms. Principal concern of NASA in its current negotiations with the two firms on *Apollo* systems engineering and integration contracts is how to benefit from these two leading technical sources without giving them a competitive advantage or over-restricting them on future manned space flight R&D contracts.

### No Cure for Nimbus Slippage

In the future military users of the *Nimbus* weather satellite system require program urgency, they so far have given no such indication to the space agency, according to NASA's Dr. Morris Tepper. He told the House Space Committee he doubts pumping more money into the program will prevent the currently estimated 6-month to a year slippage. DOD's John Rubel, meanwhile, refuted Air Force testimony that DOD is considering its own weather satellite (M/R, Sept. 3, p. 14).

### Astronaut Final Selection Close

Space agency officials now plan to announce the names of the new group of astronauts later this month. Five to 10 will be selected from a final list of 20. The astronauts will make their first flights in the *Gemini* two-man spacecraft flight series beginning in 1964.

## INDUSTRY

### Next Mercury Booster Readied

*Atlas 130 "D"*, which is scheduled to carry *Mercury* capsule *MA-9*, is now undergoing final checkout of electrical and mechanical systems on the assembly line at General Dynamics/Astronautics. Meanwhile, a static test on *MA-8*, first ever scheduled on a manned booster at Cape Canaveral, was scrubbed last week. Test was intended to check out new baffle injector plates installed to give a better mixture of LOX and RP-1. No reason was given.

### Operation Successful, Reactor Damaged

First ground tests of the *Kiwi-B-1B* reactor system using liquid hydrogen as the propellant were completed by the AEC's Los Alamos Scientific Laboratory. Previous tests using other reactors employed gaseous hydrogen. The reactor was damaged during the test run. Cause is still unknown.

### Escape Chute Under Test

The personnel parachute Northrop-Ventura is developing and qualifying for *Gemini*'s ejection seat system is undergoing low altitude drop tests from a C-133 at El Mirage Dry Lake, Edwards AFB. Parachute and seat, weighted to simulate a passenger, are pushed from the aircraft on a rig from which the seat ejects. Northrop also is developing a steerable parachute suitable for both personnel and vehicles.

### Gemini Design Approved

NASA has given McDonnell Aircraft Corp. the manufacturing go-ahead for the *Gemini* spacecraft. The order followed an engineering evaluation session of the spacecraft mockup in mid-August. Space agency officials approved the design with only slight changes recommended.

### NASA Procurement Study Due

Procurement officials have given top space agency brass a status report on their study of NASA contracting policies. Originally scheduled to be completed about Sept. 1, final report and recommendations, they say, will be delayed for a few weeks. Primary objective is a review and improvement of contractor source selection and evaluation.

## INTERNATIONAL

### UK Reports Largest Electronics Shipment

The Scorpion radar system, built by Associated Electrical Industries, Leicester, England, has been shipped from Liverpool to the Woomera Test Range for use in testing the *Bloodhound II* guided missile. Weighing more than 80 tons, the system is believed to be the largest electronic consignment ever to have been exported from the UK.

### Alouette Launch Date Fixed

Launch date for Canada's *S-27* "topside" ionospheric-sounder satellite now is Sept. 28, according to NASA officials. It will be sent into a polar orbit from the Pacific Missile Range. Booster is a *Thor-Agena*.



**THIS MAN NEEDS HELP.**

He is sitting on a frictionless chair in a pitch-black room at the Life Sciences research facilities at Vought Astronautics Division. Robbed of all sensual references save the image within his eyes, he finds himself in the same predicament as a future astronaut trying to pilot his craft to an orbital rendezvous with another object. ■ As his chair glides toward the target, he reports a collision course even though he will miss it by almost fifteen degrees. His estimate of the closing rate is dangerously over-confident. You would find he needed help — if you tried it yourself. ■ This experiment demonstrates Vought's acute awareness of man in the space craft. Contracted and in-house studies are helping him learn to survive and work in the alien environment of outer space. Vought Astronautics is also at work on orbital rendezvous, the DYNA-SOAR nose cap, SATURN first-stage fuel tankage and is prime contractor of NASA's SCOUT rocket system. Write today for the story of the concept-to-countdown capabilities of Vought Astronautics Division.

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# The Missile/Space

## New Titan III Details

First *Titan III* "A" configuration is scheduled for launching 21 months from the go-ahead date on the program, which was Aug. 11. This puts the launch date in May, 1964. Dates were disclosed last week by the Air Force.

The "C" configuration is to make its first flight in January, 1965. First of the "C" configurations is scheduled to carry a payload, probably orbital, and the third will carry an unmanned *X-20*. Third *X-20* flight is to be manned.

Present plans call for the third stage of *Titan III* to have a three-start capability. It will be replaceable by *Centaur*.

The "A" configuration, which does not have the 120-in. solid boosters, will be assembled and launched from Pad 20 at the Cape. Modifications to that pad will start soon.

Designs now have been completed for *Titan III* complexes 40 and 41 at the Cape. AF plans to call for site preparation bids within the next 30 days.

Complex 42, also intended for the "C" configuration, has been sited but will not be built as yet.

Initial estimates call for expenditure of more than $60 million for the complete Integrated-Transfer-Launch complex (ITL). The main integration building will stand 320 ft. high. It will be 315 ft. long and 192 ft. wide. The solid motor mating structure will measure 250 ft. long, 240 ft. high and 140 ft. wide.

Plans call for the pads to be located 8000 ft. apart on the ocean front.

*Titan III* will be assembled in the integration building in a vertical position. It then will be moved by rail to the solid mating building where the five-segment first stage solid motors will be strapped on the liquid propellant second stage.

Pad time is expected to be only six to eight days, permitting an accelerated rate of firing.

## Shots of the Week

An improved first stage for NASA's *Scout* launch vehicle was successfully flight tested Aug. 30, from Wallops Island, Va. The Aerojet-General Algol II motor, 30 ft. long and 40 in. in dia., develops 100,000 lbs. thrust. It is the largest solid motor used to date in a NASA program.

The improved *Scout* launched an


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experimental payload to observe effects of atmospheric heating on a spacecraft re-entering at orbital speeds.

• A failure of the *X-15's* stability control system forced Air Force pilot Maj. Robert Rushworth to switch to his emergency control system Aug. 29 over Edwards AFB, Calif. It was the fourth failure of the automatic control system in as many flights.

Temperatures of about 1100°F caused the plane's wings and tail edges to glow red and its speical alloy skin to crack and pop under the heat-caused expansion stresses. The flight was another in a series to test high speed re-entry maneuvers for the *X-20*.

## Kennedy Tours Space Installations

The President will make a two-day inspection tour of space installations this week. He will visit Cape Canaveral and *Redstone* and *Saturn* operations at Huntsville, Ala., on Tuesday. The next day he will see the Houston Manned Space Flight Center and McDonnell Aircraft's *Mercury* capsule plant in St. Louis before returning to Washington Wednesday night.

The presidential party will include Secretary of Defense McNamara, NASA and Budget Bureau officials and congressional space committee members. Trip is billed as "strictly business" in connection with planning the FY '64 government budget.

## Bomb Test Ends Space Data

The radiation belt created by the July 9 U.S. H-bomb blast has knocked out all transmission from three satellites: *Transit 4-B*, TRAAC, and the U.S.-launched, British *Ariel*. *Injun* continues to broadcast as before, and *Telstar* appears to be unaffected by the radiation. Official announcement of the damage confirmed M/R's August 27 report.

## AF Reorganizes R&T Staff

A major realignment at the Air Staff level of the Air Force has focused responsibility for all space projects in the office of Lt. Gen. James Ferguson, Deputy Chief of Staff for Research and Technology.

Included in the transfer, effective Sept. 1, were: *MIDAS, Satellite Inspector, Dyna-Soar (X-20),* DOD communications satellite systems, *Titan III* and the large solid rocket program. Significantly missing from the list, however, was *SAMOS*. This system and the *Agena D* were not transferred to R&T from the Deputy Chief of Staff for Systems and Logistics.

The criterion for transferring space systems was reportedly their research and development status. For example, *Agena D* was not transferred because it is essentially a production item. This would indicate *SAMOS* is now operational.

The primary purpose of the reorganization was to centralize all AF space activities under a single staff agency. The realignment will also provide DOD with a single source for information and coordination of its program package VI (Research and Development). In the past, this lack of a single AF source for package VI activities has been criticized by DOD.

In essence, the realignment and transfer of staff responsibility and personnel responsible for space programs is a return to the situation which existed before mid-1961. The DCS/Development then was charged with systems R&D up to the point of production procurement.

In 1961, however, the DCS/Development was redesignated RCS/R&T and charged with basic and applied research, advanced technology and development planning. The DCS/Systems and Logistics took over responsibility for both advanced systems development and procurement.

Under the realignment, DCS/S&L will retain responsibility for system production procurement and logistic support and for those development projects near completion and associated with series production.

Coordination between the two staff agencies will be effected by a joint programing office.

## Modification at the Cape

The Army Corps of Engineers has announced that Complex 12 at Cape Canaveral will be modified to service larger and more sophisticated space vehicles. *Mariner* and *Ranger* shots were made from this pad.

The upper portion of the tower will be modified to accept the larger vehicles, the existing 7½-ton crane will be replaced by a 10-ton model, air-conditioning will be installed in an upper level work area, adjustable work platforms will be modified and additional electrical service will be provided to the tower and launch pad.

Bids on the work, expected to cost about $350,000, will be opened Sept. 27. Work will have to be completed within 97 calendar days, broken by three periods when NASA will fire exploratory rockets from Complex 12.

## Nuclear Space Hearings

Public and executive hearings to look into the management problems of large space-nuclear-powerplants as well as the status of projects *Rover, Snap, Pluto* and *Orion* were rescheduled to Sept. 11-13. To be held by the Subcommittee on Research, Development and Radiation of the Joint Committee on Atomic Energy, the hearings originally were set for last week.

## Economy ComSat Terminal Tested

An experimental version of a low-cost ComSat ground station capable of handling a single two-way voice or data channel was successfully tested via *Telstar* by Bell Telephone Labs last week.

Operated in conjunction with the massive Andover, Mass. facility, the Holmdel, N.J., mini-station also simulated very-long-range communications between two such small units by using a voice path to and from *Telstar* before demodulation.

The single channel station was built in two weeks with available equipment including a "war surplus" 18-ft. dish antenna. A refined facility would cost between $250,000 and $500,000 but Bell has no specific plans at the moment.

The Holmdel experiment was not designed to compete with the larger, 12-channel mobile ground station being developed by ITT for the Project *Relay* communications satellite system. But the Bell ground station may evenutally become a reality for fund-limited countries and organizations desiring a communications satellite tie-in.

## USSR Plans Sun-Data Shots

Russia has revealed plans for special rockets and unmanned satellites to obtain information about the Sun. The research would be performed in connection with worldwide "International Year of the Quiet Sun" activities.

*For Apollo spacecraft . . .*

# Nine Firms Bid on Lunar Module

***NASA expected to let contract in six to eight weeks for LEM vehicle; award may exceed $500 million mark***

NINE FIRMS have submitted contract bids for the *Apollo* spacecraft's Lunar Exploration Module. Contract for the two-man *LEM* will probably total well over $500 million. NASA announced that the contractor would be selected in six to eight weeks.

NASA also selected Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp. to study design of a lunar logistics vehicle.

The nine firms submitting bids for *LEM* are Lockheed Aircraft Corp., Boeing Co., Ling-Temco-Vought, Inc., Northrop Corp., Grumman Aircraft Engineering Corp., Douglas Aircraft Co., General Dynamics, Republic Aviation Corp. and Martin Marietta Corp.

Two firms that were invited to take part in the procurement action but did not submit bids were McDonnell Aircraft Corp. and North American Aviation, Inc.—prime contractors for the *Gemini* and *Apollo* programs.

*LEM* will detach from the *Apollo* spacecraft while in lunar orbit and descend to the Moon's surface. After lunar exploration, the spacecraft—using its own propulsion system—will leave the Moon and rendezvous with orbiting *Apollo* command and service modules.

• **Lunar Logistics System**—A three-month contract was awarded to Space Technology Laboratories for the study of various spacecraft that could carry supplies to a lunar exploration party. Major objective of the $150,000 contract will be to determine how subsystems in a 9000-lb. vehicle carrying 1500 lbs. of equipment might form the basis for a 90,000-lb. vehicle carrying 20,000 lbs. of equipment.

The Northrop and Grumman contracts are also three-month studies, each worth $75,000. The firms will conduct separate studies of single cargos—life support equipment, survival gear and roving vehicles—for the smaller spacecraft and combinations of cargos for the 90,000-lb. spacecraft.

• **Nova Launch Facilities**—NASA also issued proposals to 32 companies for a *Nova* launch facilities study. The firms were invited to submit bids by Sept. 17 with the contract expected to be awarded about Oct. 1. The chosen contractor will have to work closely with two companies, General Dynamics/Astronautics and Martin Marietta Corp., which are conducting concurrent *Nova* systems definition and preliminary design studies.

In the first phase of the launch facility study, ending by December 1962, the contractor will develop preliminary information on launch facilities for the most promising *Nova* configuration.

A follow-on second phase will be negotiated for a detailed comparative analysis of each promising launch concept, including cost of construction and operation, land requirement, transportation, logistics, construction time and environmental safety. The study will end in mid-May, 1963.

*Nova* will be launched from a land-based station at Cape Canaveral. One well-removed launch control center will be used for all launch pads.

Both "fixed" and "mobile" concepts are to be considered. Under the "fixed" plan, the rocket would be assembled, checked, and fired from the launch pad. The "mobile" plan requires that the vehicle be assembled and checked out in a vertical assembly building and transported to the launch site in ready condition.

The 32 firms are: Aerojet General; American Machine & Foundry Co.; Beech Aircraft; Bechtel Corp.; Boeing; Chrysler Corp.; Consolidated Western Steel; Cook Technological Center; Browne Engineering; Cal-Val Research & Development Corp.; Dames & Moore; Daniel Mann, Johnson & Mendelhall; Douglas; Ford Aeronutronic; General Dynamics; Kaiser Engineering Co.; Martin Marietta; Maurice Connel & Assoc.; National Engineering Science Co.; North American; GE; Ralph M. Parsons; Roberts & Shaeffer; Siegler; Sperry-Gyroscope; Northrop; Rust Engineering Co.; Westinghouse Electric Co.; Vitro; Jackson & Moreland; N. W. Kellogg Co.; and B. K. Instruments, Inc. ⌗

## Soviet Space Failures Are Disclosed

Six unsuccessful Soviet attempts to send instrumented space probes to Mars or Venus were disclosed last week by the U.S.

The Russian failures were revealed by NASA Administrator James Webb in response to a letter from the chairmen of the Senate and House Space Committees, Sen. Robert Kerr (D-Okla.) and Rep. George Miller (D-Calif.).

Four of the failures never have been announced and a fifth was passed off as a successful orbital attempt, Webb revealed. He said his information was obtained from "appropriate government agencies."

The Soviets employed the same procedure as the U.S. in the interplanetary attempts: launch into a parking orbit followed by ejection on an interplanetary course. The U.S. announcement said the Russians used three booster stages to achieve orbit and a fourth for ejection into trajectory.

"We feel it is about time for the world to know of the Russian failures," said a spokesman for the Senate Space Committee.

The list of Soviet failures:

• **Oct. 10, 1960.** An unannounced attempt at a Mars probe.

• **Oct. 14, 1960.** With Premier Khrushchev at the U.N., a second and unannounced Mars probe failed to achieve parking orbit.

• **Feb. 4, 1961.** A Venus probe was placed in orbit but failed to eject. It was claimed by the Soviets as a successful orbiting of *Sputnik VII*.

• **Feb. 12, 1961.** An announced Venus probe achieved interplanetary trajectory but its radio transmitter failed at 4.5 million mi.

• **Aug. 25, 1962.** A third attempt at a Venus probe failed to eject from orbit.

• **Sept. 1, 1962.** The fourth attempt to reach Venus failed when it did not eject successfully from its parking orbit. ⌗

***Reduction in payload...***

# Centaur Redesign Threatens Surveyor

***Drop in lifting capacity may also snag weather and communication satellite programs***

**by Hal Taylor**

NEW DESIGN recommendations are cutting down the payload capability of *Centaur* and forcing other extensive changes in the liquid hydrogen upper-stage vehicle.

The drop in lifting capacity is so great that the *Surveyor* lunar landing mission is in jeopardy. Also likely to be affected are the *Mariner*, weather and communication satellite programs.

The design changes, resulting from a re-evaluation of the program by NASA scientists, are causing sharp increases in vehicle weight and a resulting drop in booster efficiency.

Space agency officials refused to say just how much, but one official declared that "the reduction in payload is enough to scare us. There is a good possibility that we may not meet the *Surveyor* mission requirements."

One solution being considered calls for the use of a new first-stage booster for the liquid hydrogen upper stage. Under the proposal, the more powerful *Titan II* would replace the currently planned *Atlas*.

Another alternative would be to reduce the weight of the 2100-lb. *Surveyor*. This might cut the chances of success for the spacecraft designed to provide the first detailed information about the Moon before the U.S. manned lunar landing flights.

The recommended changes in design are the result of a technological review of the *Centaur* by scientists at NASA headquarters and the Marshall Space Flight Center.

The review was ordered by the House Space Committee after public hearings to determine why the upper stage program was 18 months late.

The committee ordered NASA to report back by Aug. 1 its findings on what was wrong with the program and how it could be accelerated. The report has been delayed because of the many recommended design changes. NASA officials, however, have informed the committee that it will be ready before the end of this month.

While NASA refused to discuss the report except to admit the loss of payload capability, informed sources report it will:

- Call for a sharp increase in *Centaur* funding including a Fiscal '64 budget request of about $100 million—far higher than earlier estimates. In Fiscal '63, an additional $30 million above the $67 million approved by Congress will be obtained by reprograming funds from other space agency programs.
- Indicate that *Centaur* will not be operational until mid- or late 1965, two years late.
- Reveal that in order to increase its payload for missions calling for 22,300-mile-high orbits, the *Surveyor* spacecraft's propulsion unit will be used as a *Centaur* second stage. It will provide an additional 1000 lbs. of payload.

The space agency has decided that *Centaur*, despite its many troubles, is still feasible. While other industry proposals for upper stages have been studied, NASA intends to push ahead.

There will be further delay in the second launch of the upper stage, currently scheduled for March, 1963. ⌗

## *Mariner Is Set on Venus Course*

SUCCESS of *Mariner II* was virtually assured following a mid-course guidance correction which will send the spacecraft within 9000 miles of Venus.

Only the successful transmission of data from two planetary experiments stands in the way of a major U.S. victory over Russia in the space race. This will be attempted on Dec. 14, 1962.

The vital mid-course maneuver was executed at 6:49 p.m. EDT Sept. 4, at a distance of 1,492,500 miles—the greatest range at which man has ever changed the trajectory of a spacecraft.

At that time, the spacecraft was traveling at 6780 mph on a course which would have taken it 233,000 miles from the planet.

Three coded commands were sent to the spacecraft and stored in its command and control system.

The first ordered the spacecraft to roll 9.33 degrees. The second command ordered a pitch maneuver of 139.85 degrees. The third ordered the spacecraft's mid-course correction motor to burn for 29 sec.

As soon as receipt of the commands by the spacecraft had been verified, an "execute" signal was sent by the Goldstone, Calif. tracking station which automatically triggered the whole command sequence at the specified times.

It required 51 sec. for the roll maneuver, and 13 min., 15 sec. for the pitch maneuver. The pitch maneuver turned the spacecraft almost completely around so that the brief 29 sec. motor burn served as a retro-rocket to slow the spacecraft by 69.5 mph to make the course correction.

Mariner still faces some 14 weeks of space flight and the continuing dangers of temperature extremes, space radiation, cosmic dust storms and possible collisions with meteorites.

The spacecraft has been sending back data obtained from four of its experiments. These are measuring the planet's magnetic field, charged particles, cosmic dust and solar plasma in space.

Its two most important experiments—designed to provide information on the planet's temperature and atmosphere—will not be turned on until about 10 hours before planet encounter.

The first *Mariner* launch July 22 failed when an erroneous guidance signal sent its *Atlas* booster off course.

W. A. Collier, Asst. *Mariner* Project Manager at the Jet Propulsion Laboratory, said, "This has been a shot in the arm for everybody at the lab, and I believe a pretty good shot in the arm for the whole country." ⌗

*At Seattle meeting . . .*

# Scientific Leaders Attack DOD Policy

## *Cautious approach in systems development hit by government and industry scientists; NASA policy also comes under fire*

**by Donald Zylstra**

SEATTLE—Greater industry autonomy in research and development effort may still be the speediest route to operational space and military systems.

This was the view expressed at last week's National Advanced Technology Management Conference by Lt. Gen. Leslie R. Groves, who directed the highly successful Manhattan project in World War II. Dr. Edward Teller, developer of the H-bomb, and other top scientists in government and industry joined Groves in deploring present development effort.

Their comments were in sharp contrast to policies espoused by DOD comptroller Charles J. Hitch, who outlined a cautious approach: delaying orders to develop new systems for as long as possible.

When rigid division of scientific effort patterned after the Manhattan program has been followed, it has proved equally successful, Groves said, citing the success of Navy's *Polaris* program.

• **Saddle sore**—Capricious changes in priority and failure to grant essential autonomy to program directors has wrecked many system development efforts in Groves' view. Top officials responsible for systems development shouldn't be saddled with the responsibility unless it's matched by comparable authority, Groves emphasized.

Openly critical of current approaches to development, Groves said: "Lately new philosophies are being urged on us by men who feel management experience is unnecessary. They feel all that's needed are just a few bright young men, with little experience except as students at a certain top university. I wouldn't meet today's qualifications. I was a graduate of West Point. I didn't attend Harvard."

Groves deplored growing tendencies toward empire building and establishment of new agencies to direct and guide weapons system research and development. "We never tried to do anything ourselves that an established industrial firm, university or other existing agency could do for us—given the proper autonomy, complete control and support," he said. "We felt we needed to get research projects out of the laboratories and into production as speedily as possible."

• **Trailing Soviets** — The cautious approach being taken by the Department of Defense and NASA in their handling of space programs will put the United States even farther behind in its race with the Soviets, Teller says. Teller said the nation must "take chances" to assure scientific progress.

A nation that was unquestionably the most powerful on earth after World War II because it possessed the atom bomb and other potent weapons has lost its exclusive position, Teller said. "We led in military strength, wealth, science and technology and in the world's admiration for our achievements," he noted. "Now the only safe assumption is that we're still the world's wealthiest nation.

"Whatever the reason for this decline, the present situation is a dangerous one. Now that many countries have access to fissionable materials, we must excel in our management of engineering facilities if we are to lead. The Manhattan project marked the first time the scientific community faced 'the type of reality where today's theorizing and development will be next year's weapons or space system, or change the fate of the world next month.' "

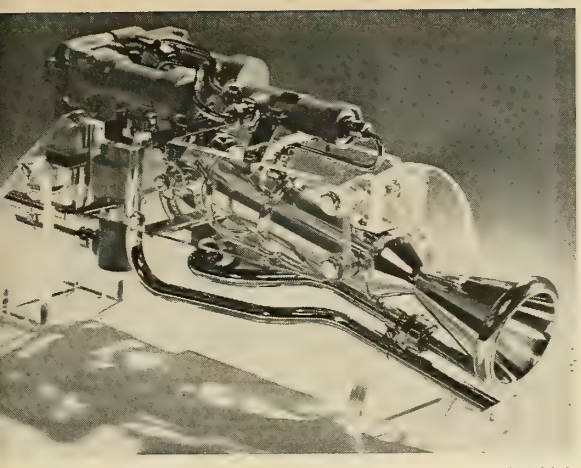
Teller emphasized that with the advent of the A-bomb development, scientists who had habitually considered their ideas their own were forced to give them up "prematurely" for development. They found the compartmentation of the A-bomb effort shocking and abhorent. Urgent need for the weapon system forced them to work without their customary access to work their colleagues were doing in related areas of the same program.

Dr. John R. Pierce, director of research in communication principles for Bell Telephone Laboratories, found other things wrong with present approaches to systems development. "Really new things are generated not from needs, but from possibilities," Pierce insisted. Early research demonstrating needed breakthrough or the most advanced development in a proposed system must precede a detailed, completely functioning design where it's feasible, he said. In citing *Echo* and *Telstar* as examples of this approach, he noted that inclusion of detailed specifications and complex design too early may lead to unwarranted delay or failures.

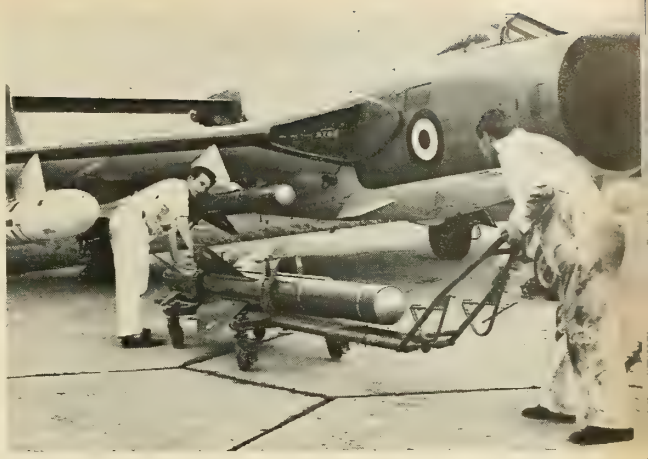
Without mentioning it by name, he implied that the *Advent* program was such a case. Procedures in the Army's effort in this instance "did indeed lead to a satellite program of great cost and magnitude which has not yet involved the launching of any satellite, and has not resulted in any clear advance in the arts of communication of space." The reoriented *Advent* program is now an Air Force responsibility in an effort to streamline and reduce satellite weight to permit launching by a rocket smaller than the failure-ridden *Centaur*. Pierce also pleaded for more autonomy and less interference with scientists, once a development program is ordered.

Hitch in his advocacy of long, detailed scrutiny ahead of any development order, was virtually alone among other early speakers at the conference.

"We should have reasonable confidence that a system, even if technologically successful, will justify its cost," he emphasized. "We want to plan as much as possible before we begin spending money." Only where an urgent need and clear prospect of a sizeable increase in performance is apparent is any more enterprising, daring development approach justified in Hitch's view. ⌗



*INDOOR EXHIBITS at Farnborough included the Bristol Siddely PR-37 liquid-propellant rocket engine designed as a boost motor for the Australian Jandivik pilotless target aircraft.*



*OUTDOOR EXHIBITS included the de Havilland Red Top, which has a collision course interception capability and will replace RAF and Royal Navy fighters.*

***Blue Water is missing...***

# Missile Gap Hits Farnborough Show

## *BAC's Bloodhound 2, Thunderbird 2 unveiled for public; both have improved guidance systems; Vulcan under wraps*

FARNBOROUGH, ENGLAND—Signs of the British government's recent missile contract cancellations were much in evidence here at the annual exhibition of the Society of British Aircraft Constructors. The show's Guided Missile Park appeared half empty when the show opened last week, and a promised *Blue Water* indoor exhibit was not to be seen.

The exhibit did show two British Aircraft Corp. missiles to the public for the first time, however. They are the Bristol/Ferranti *Bloodhound 2* and the English Electric *Thunderbird 2* surface-to-air missile systems.

*Bloodhound 2* is fitted with continuous-wave radar guidance, but is otherwise much like *Bloodhound 1*, now operational with units in Britain and Australia. *Bloodhound* is also now a key weapon of air defense in Sweden and Switzerland.

*Thunderbird 2* also has new guidance, as well as improved ramjets. *Thunderbird* is claimed by BAC to have been considerably improved in low-level performance, range and speed as well as killing ability and resistance to enemy countermeasures.

• **More from BAC**—Among BAC's other prize displays were *Vigilant* and *Malkara* antitank weapons and the *Ariel* satellite. Inertial Guidance Europe, a Paris firm owned by BAC and Minneapolis-Honeywell, featured gold-plated *Centaur* equipment.

A feature of the Hawker-Siddely Aviation exhibit was a full-scale Whitworth-Gloster *Seaslug*, the Royal Navy's ship-to-air beam-riding guided weapon. Guidance receiver for *Seaslug* was shown in detail at the cutaway display of GEC Electronics, Ltd., designer of the guidance system.

De Havilland Aircraft Co., Ltd., showed its *Firestreak* and the *Red Top* that will replace it as a standard weapon aboard Navy *Sea Vixen* fighters and RAF *Lightnings*. The two infrared-homing, air-to-air missiles were shown both on stands and fitted to aircraft.

• **Vulcan under wraps**—The only aircraft to which the press was denied close access was an Avro *Vulcan* equipped with a *Blue Steel* tactical air-to-surface missile. Prime reason may be Elliott-Automation, Ltd.'s inertial navigation system for *Blue Steel's* stand-off bomb, now in production by Elliott Brothers, Ltd., under contract from the Ministry of Aviation. Reportedly its Farnborough display was allowed only with an "all covers on" stipulation.

A private venture by Short Brothers and Harland, Ltd., is *Tigercat*—land-based, vehicle-mounted version of seacat—which was revealed at Farnborough. The ship-to-air, radio-command-guided *Seacat* recently passed its sea trials successfully. West Germany, Sweden, Australia, and New Zealand have reportedly ordered *Seacat* batteries.

*Jindivik*, a pilotless target craft of Australian design, was shown at one stand while its small-boost motor was displayed by Bristol-Siddely in another area. The motor, which uses hydrogen peroxide and kerosene supplied by nitrogen under pressure, has a 170-lb. maximum thrust at take-off. It is mounted under the *Jindivik* fuselage, with propellants in two pods below the wings.

The Ministry of Aviation demonstrated its liquid propellant mixture ratio control system, presently in use only at the Ministry's Rocket Propulsion Establishment, though Spadeadam is expected to have the system soon.

The de Havilland *Blue Streak* again monopolized the Missile Park scene, this year partly cut away to show internal equipment details. *Blue Streak* has been selected for the European Launch Vehicle first stage.

Also of interest was Elliot-Automation, Ltd.'s VERDAN D.9.D. airborne digital computer, now in production. The D.9.D. may replace large complexes of analog equipment for certain applications. It has been designed with ability to communicate with other computers and computing systems. ⌗

*In Gilpatric speech...*

# Military Space Move Left to Russians

DEPUTY SECRETARY of Defense Roswell Gilpatric last week reasserted U.S. intentions to exploit space for peaceful purposes only and left any extension of the arms race into space squarely up to the Soviet Union.

"We have no program to place any weapons of mass destruction into orbit," Gilpatric told a meeting of Midwest industry and university representatives in South Bend, Ind. He departed from the topic of his speech to make what obviously was a major policy announcement.

"An arms race in space will not contribute to our security," he asserted. "I can think of no greater stimulus for a Soviet thermonuclear arms effort in space than a U.S. commitment to such a program. This we will not do.

• **Defense paramount**—"We will of course take such steps as are necessary to defend ourselves and our allies, *if the Soviet Union forces us to do so.*" (Italics added.)

In what appeared to be a direct appeal to the Soviets to restrict the arms race to Earth, Gilpatric said that the U.S. believes "it is highly desirable for its own security and for the security of the world that the arms race should not be extended into outer space, and we are seeking in every feasible way to achieve that purpose.

"Today there is no doubt," he noted, "that either the United States or the Soviet Union could place thermonuclear weapons in orbit, but such an action is just not a rational military strategy for either side for the foreseeable future."

(Air Force officials, testifying before Congressional committees on the FY '63 budget, have indicated that the Soviets may be pursuing development of orbital weapons. The source of this intelligence is at best hazy and appears to center around Premier Khrushchev's boast of a "global rocket".)

Gilpatric stressed that the U.S. fully supports the resolution unanimously adopted by the United Nations Dec. 20, 1961 for the peaceful development of space.

• **Reiterating U.N. stand** — Sponsored by the U.S., the resolution recognizes the interests of mankind in the peaceful uses of space and expresses the belief that space should be used only for the betterment of mankind. It also establishes the principal that space and celestial bodies are free for exploration and use by all nations and not subject to expropriation by any nation.

"We see no reason to change our position about this resolution," Gilpatric asserted.

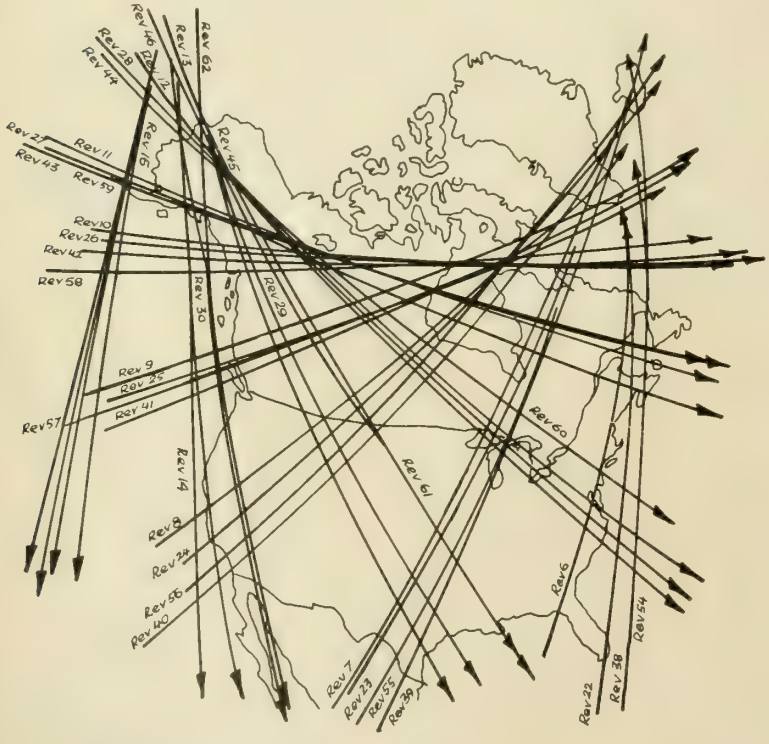
The plea for restraint in space weaponry was so obvious a digression from Gilpatric's speech on "Research and Development as a Factor in Defense Procurement" that it could only reflect the desire of Defense officials to use the first available platform to inform the Soviet Union of our military space intentions. It also reflects the Administration's desire to check the accelerating arms race and to introduce a modicum of stability into the "balance of terror."

In line with this, Gilpatric outlined the two main objectives of the "active and extensive" U.S. military space program:

—To ensure that the United States will be able to cope with any military challenge in outer space. "Our programs in this area are under constant review, and this review indicates that our present rate of effort is entirely adequate."

—To actively explore, along with NASA, the potentialities of outer space as a useful part of our expanding universe, particularly in the fields of communications, navigation, meteorology, mapping and geodesy.

These programs, Gilpatric pointed out, "have great significance not only for our military forces but for the economic and scientific advance of the United States and of the whole world." ⠿




## *Vostok Paths Over North America*

*THE POTENTIAL THREAT to North America inherent in Soviet manned orbital flights is starkly portrayed in this unique drawing charting the paths of Vostoks III and IV. Chart was prepared by NORAD's space detection and tracking system, NORAD officials said that if Cosmonauts Nikolayev and Popovich had carried launchable warheads, they could have zeroed in on any point in the U.S. or Canada.*

## *Modified T-38 . . .*

# Northrop Proposes Space Trainer

**by Willard E. Wilks**

NORTHROP CORP.'S entry in the space-trainer competition informally sponsored by the Air Force Aerospace Research Pilot School may be a modified *T-38*—outfitted with rocket engines instead of jets to enable it to reach a height of 50 mi.

The company's Norair Div. revealed last week that wind-tunnel tests in support of the project are due to start this month.

Northrop thus joins several other major aerospace concerns submitting proposals to the Edwards AFB, Calif., school (M/R, Sept. 3, p. 12).

• **Upgrading the T-38**—A new engineering study shows that a *T-38* space-trainer can be sent to at least 250,000 ft., according to W. E. Reese, Norair chief, advanced aircraft group, marketing. He said this is considerably higher than proposed in a company study completed several years ago.

Reese added that the new craft would retain more than 90% of the *T-38's* basic structure.

In response to Air Force requests, the company is trying to squeeze an additional 14,000 ft. out of the trainer—designated *N-205B*—to bring it to 50 mi. This would qualify the craft as a training vehicle for astronauts—a prime selling point to the Aerospace Research Pilot School.

While Norair released no cost estimates, company spokesmen with an eye on North American's *STX-15* study, said the *N-205B*—"will provide the most reasonable space-trainer available, permitting actual space-flight training without going into an expensive space vehicle."

Whether *N-205B* altitude could be stretched to 50 mi. depends mainly on the rocket powerplants that would replace the *T-38's* jet engines—"whether we can attain high enough specific impulse so we can cut weight," Reese said. The Norair study is evaluating a variety of rocket engines—liquid, hybrid and solid — demonstrated by Aerojet-General, Bell Aerosystems, Rocketdyne and Thiokol.

Best approach so far appears to be hypergolic liquid, but hybrids are receiving serious consideration. "A recent hybrid evaluation looks very good," a spokesman said, "in some ways, perhaps, better than liquid."

• **Performance** — Total thrust requirement for the *N-205B* is 30,000 lbs. with fuel burnout at 90 sec. Norair is undecided whether two or three engines will be proposed. The earlier study recommended three liquid rockets.

Gross takeoff weight—with takeoff in the conventional manner as opposed to the 70° launch from an erector as proposed earlier — would run about 20,000 lbs. (compared to 11,680 for the *T-38*). Landing weight would be about the same as the *T-38's*.

Speed would be Mach 3-plus. Higher speeds would require use of steel, at least in the leading edges; Norair wants to avoid this to keep cost as reasonable as possible.

As long as speed is held down, the *T-38's* aluminum skin should be adequate even for re-entry from 50 mi., Reese said. "Main objectives are to provide practice with reaction controls and re-entry training," he noted.

• **Materials** — A computer study program currently under way shows certain portions of the *N-205B* would heat to 474°F for very limited periods, and use of steel would be unnecessary. A 2500-hour computer flight showed no appreciable structural degradation, Reese reported.

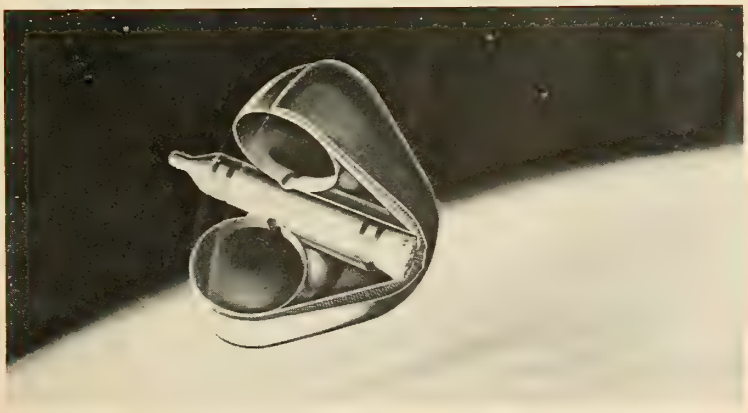
While the *N-205B* would involve no major material changes over the *T-38*, a different bonding agent would be necessary for the honeycomb structure of the control areas and landing gear doors, according to Norair. Heat-resistant glass would be substituted for plastic in the canopy, which probably would not be full-vision.

Cockpit would be conditioned and pressurized at five psi, with pilot wearing a pressure suit. Cabin temperature would be maintained below 100°F.

Forthcoming empennage wind-tunnel tests will provide data for re-design of the large ventral fin included in Norair's earlier study. With the *N-205B* utilizing conventional takeoff to gain higher altitude, the fin would have to be eliminated or folded.

Northrop, with considerable experience in past high-speed sled programs, favors conventional takeoff over sled launch as the most desirable for both safety and training reasons. This is opposed to North American Aviation's *STX-15* plan, which proposes sled launch among others. "Sled launch is too dangerous if anything goes, if there's a tiny kink in the rails," a spokesman said.

Completion of Norair's *N-205B* study is expected by mid-October. ⌗



### *Novel Recovery System for Space Boosters*

DOUGLAS SCIENTISTS have proposed a novel recovery system for space boosters—ROOST, an acronym for Reusable One-Stage Orbital Space Truck. After payload separates from booster, left-over liquid hydrogen fuel inflates two huge heat-resistant Goodyear fabric bags, forming for the booster a conical protective structure able to withstand 1800°F. Blunt-nose design limits maximum re-entry temperature to an expected maximum 1500°F; air resistance settles load onto Earth at calculated one mph.



*Inflatable micrometeoroid paraglider (IMP) in Langley tunnel.*

## *Inflatable paraglider...*

# IMP Flight Tests Start in Mid-1963

### *NASA will use Aerobee rocket to launch research vehicles in experiments to study micrometeorite particles*

NASA PLANS a series of flights with an inflatable paraglider to determine its re-entry characteristics and to measure the size of micrometeorite particles in space.

First flight in the series is scheduled for mid-1963. The second flight will follow shortly after.

Space agency officials also disclosed that the feasibility of a similar "Rogallo" wing for use on the *Gemini* spacecraft had been proved in a series of tests at Edwards Air Force Base. The favorable report of NASA scientists followed more than 50 flight tests with a piloted "Rogallo"-winged glider.

• **Mercury application**—The NASA-built vehicle was towed to a height of 5000 ft. by a light aircraft, then released and brought to "spot" landings by a research pilot. Officials said the tests will continue and Project *Mercury* astronauts may make training flights on the glider.

Flight tests with the inflatable paraglider will be made at much higher altitudes in high-speed tests designed to provide further data for use in the U.S. manned lunar landing program.

The paraglider will be launched by an *Aerobee* research rocket from White Sands Proving Grounds, New Mexico, to a height of 700,000 ft. It will then descend to earth at a speed of Mach 5. Its re-entry path will be almost straight down—at an angle of 82 degrees. The inflated paraglider will be 14 ft. long with a span of 18 ft. It will weigh 170 lbs. during launch and 85 lbs. during re-entry.

Prime contractor for the program is the Aerospace Division of Aerojet-General. B. F. Goodrich Co. built the paragliders. Overall direction is being handled by NASA's Langley Research Center.

The flights are designed to provide information on frequency and size of micrometeoroid particles in space and to allow post-flight laboratory study of craters formed by such particles.

Design details indicate full-scale flight vehicle will have an inflatable frame. A flexible membrane between the frame and the suspended payload is to consist of the paraglider inflation system and the necessary telemetry instrumentation to relay micrometeoroid penetration data to ground tracking stations.

The membrane will be made of a special lamination of plastic and metal arranged to act as a condenser that will be discharged due to ionization when struck by a micrometeoroid.

The *Aerobee* rocket will carry the compactly packaged paraglider to an altitude of about 200,000 feet, where it will be ejected and inflated and will ascend to about 700,000 feet.

The experiment will check out a unique capacitance-type sensor system consisting of alternate layers of Mylar plastic and aluminum sheet, which will be attached to the paraglider wing membranes; penetration by micrometeoroids would momentarily ionize the aluminum, thus creating a telemetry signal. ⌗



*Running hull configuration tests in the model testing basin at FMC's San Jose, California plant.*

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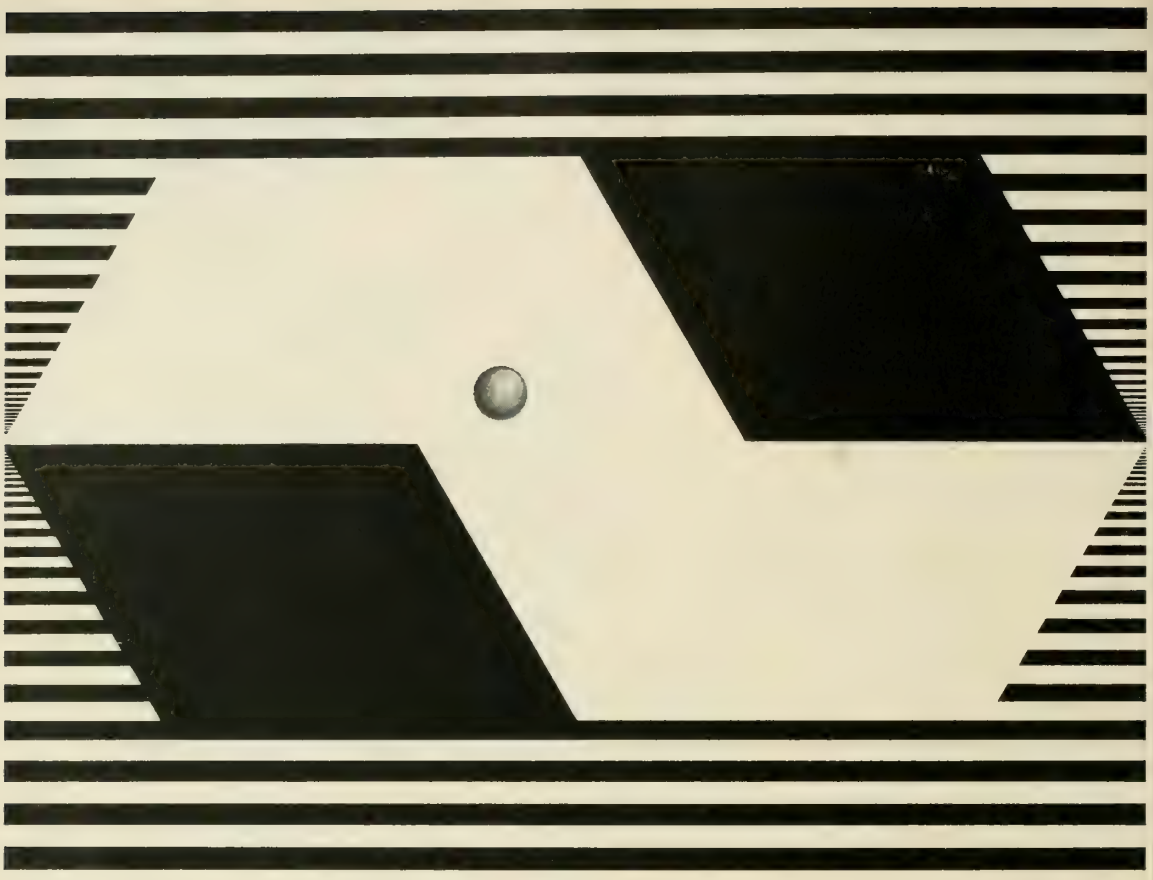
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# Technical Countdown

## ADVANCED MATERIALS

### Aeronutronic Investigates Cooled Nozzles

Feasibility of an advanced design for cooled rocket nozzles will be studied by Ford Aeronutronic under a $428,799 Air Force contract. The effects of two-phase flow on the performance of high-expansion-ratio nozzles will be covered in the three-phase program. The 14-month contract involves theory, lab studies and full scale systems, in that order. The nozzles will be applicable to extremely high altitudes or space functions.

### Porous Tungsten Poses Test Problems

The Navy is searching out ultrasonic test techniques for tungsten nozzle parts. The problem lies with those porous bodies infiltrated with lower-melting alloys—how to detect the uninfiltrated areas. Totally uninfiltrated billets cannot be ultrasonically tested unless wrapped with tape to prevent contamination. Infiltrated bodies are less bothersome. But the interpretation of ultrasonic information is difficult. The first step is a comparison of both ultrasonic and radiographic tests, but interpretation awaits billet cutting. Both methods agreed in the location of faults.

### Metal-Laminated Teflon Bladders Developed

A new process for producing metal-laminated Teflon propellant bladders, which results in substantial reduction in permeability over previous Teflon bladders, is on stream at Dilectrix Corp. The laminates, DiMetLons, also reach the highest tensile strengths in Teflon. A built-in modulated construction permits a predetermined collapsing pattern synchronized to the depletion of fuel carried by the bladder. Company officials credit this with a more precise response to propellant ejection commands and a relief from random flex stresses.

### Polyester Tapes Withstand Radiation

Radiation dosage required to cause detrimental effects to polyester-backed magnetic tapes exceed 200,000 times that termed 50% lethal human dosage, say engineers at Minnesota Mining and Manufacturing Co. The lethal human dosage refers to the amount of radiation necessary to produce death in 50% of a population. Early effects of neutron damage would be limited to activation of iron in the magnetic coating, but it is theorized that this would not produce a change in the overall magnetic properties of the iron oxide. Physical damage begins to appear after the dosage exceeds 50 megareps.

### Russians Study Explosive Welding

Solid-state welding of metals by the pressures exerted through explosions are being investigated by the Institute of Hydrodynamics of the Siberian Department, Academy of Sciences, USSR. Steel-to-steel, copper-to-copper, titanium alloy-to-itself, copper and aluminum welds have been successful. Loose trimethylenetrinitramine produced the best results but exact positioning techniques had to be used.

## PROPULSION

### Los Alamos Updates Wurlitzer

A converted 200-selection Wurlitzer jukebox is in use at Los Alamos Scientific Laboratory for studies of *Kiwi* reactor cores. Termed an "automatic foil changer" the machine uses 100 steel discs the size of 45 rpm records with a small special foil in each disc's center. The foils, containing $U_{235}$, previously have been placed at points around a *Kiwi* reactor and exposed to neutrons in the core. This causes the uranium in the foil to emit radiation, including gamma rays, which may be counted—determining the number of neutrons striking the foil during a run. The jukebox has also been adapted to punched-tape programing, eliminating the need for an operator to punch buttons for each "selection." Some modifications were made by Wurlitzer with LASL installing the counter. Foil formerly was counted manually, one at a time.

## ELECTRONICS

### Computer Malfunction Analyzer Perfected

Martin/Orlando engineers have developed an electronic fault-isolation device capable of tracing computer malfunctions down to the gate and wire level without the use of oscilloscopes and meters. The equipment isolates malfunction causes in a matter of seconds and can be operated by "anyone who can read and push four buttons." The dynamic computer chassis analyzer (MARCOMP) can check an entire chassis in 15 to 45 sec. The method eliminates the ever-present marginal performance failure possibility associated with manual trouble-shooting. Manually-checked chassis result in the failed component being repaired, but marginal components are usually missed. Martin has no immediate plans to market the analyzer, though an improved model is under consideration for use in certain military applications.

### GE Centralizes Advanced Tech Services

A corporate-level Advanced Technology Services group will operate GE's General Engineering Labs and provide technical support for the entire company. Dr. George L. Haller, general manager of the Defense Electronics Division, will head the technology organization. The operation reportedly will be funded on a division assessment basis rather than permitting the divisions to "buy" the service at their own discretion. Haller will join GE's senior management body. A new command systems division has been set up consisting of four operations taken from the defense electronics division—defense systems, military communications, electronics laboratory and lunar mission support program. R. L. Shetler, former general manager of the defense systems department, heads the command systems division.

### High Temperature Strain Gage Patented

Ilikon Corp. has been issued a patent on its ultra-high-temperature strain gage—a device capable of measuring stresses and strains up to 3000°F. All the firm's original claims were allowed by the Patent Office. Ilikon intends to license the product while continuing with its own strain gage development and marketing programs.

## SPACE POWER

### Cool MHD Process Developed

General Electric scientists are utilizing the magnetic field in an MHD generator to produce free electrons without the need for extremely high temperatures. The GE solution is based on the fact that when an electric current flows in a gas the few already-present electrons get "hotter" than the gas itself. By adjusting gas composition and the magnetic field, the electrons can be made hot enough to create ionization of a suitable additive gas without external heat additions. Simulated experiments have confirmed the discovery.

*by Fairchild Stratos . . .*

# Steam Rocket Successfully Tested

***Studies of single-stage vehicle indicate it can lift small load to 40-mi. altitude***

**by John F. Judge**

FAIRCHILD STRATOS CORP. is moving into the sounding rocket market with an economical water/solid fuel propulsion concept in the 100 sec. Isp range—an area covering a multitude of small rocket missions.

A series of test firings has demonstrated both feasibility and repeatability.

Preliminary studies by the firm indicate single-stage steam rocket configurations capable of lifting 12 lbs. to an altitude of 40 mi. would cost less than $600 per rocket on a 1000-lot production basis. A two-stage unit would cost around $1600 on the same production scale and carry 25 lbs. to 440,000 ft.

Current sounding rockets using other propulsion systems covering the same mission requirements cost $1100 for a single-stage vehicle and in the $6000 area for two stages.

Fairchild arrived at the cost figures through derivations from mass flows, density and temperature characteristics of the steam rocket to predict thrust, burning times, total and specific impulses. This computing process was verified by an outside consultant. A computation method for vertical trajectory was developed and preliminary configurations were established from it.

In operation, a water-steam reaction chamber is filled with heat-saturated water at elevated pressures—635°F and 2000 psi. A solid propellant mounted around a standpipe within the chamber is ignited, and the hot gas produced is allowed to pass through the water, transferring heat. The generated steam passes down the inside of the standpipe and expands against a nozzle, producing thrust.

• **Thermal push**—Since the water is already heated, the solid-propellant gases serve to supply the heat of vaporization, eliminating one of the drawbacks of other steam-based concepts. In the Fairchild design, none of the heat in the water is "borrowed" for the steam conversion process.

The test series consisted of eight steam-only blowdowns with the apparatus and two firings with the solid propellant system. As conducted, the tests demonstrated only the operation of the concept, and did not supply quantitative data. I. Sheldon Haas, advanced programs manager, says additional tests and other experimental work is necessary to establish design criteria.

The prime problem area is heat transfer—the mechanism by which the solid-propellant exhaust gases pass through and heat the water. This must be known to facilitate design of the exhaust gas distribution system and model scaling.

Basic to this is the flow mechanism resulting from the introduction of combustion gases into the hot water column. Haas and his associates have found the operating regime of the steam rocket beyond existing data on two-phase flow.

The effect of condensation shock on nozzle efficiency and the location and strength of the shock in the nozzle exit remain to be clarified. The nozzle itself is relatively simple and cheap in terms of materials and fabrication—aluminum or molded plastics perform more than adequately.

• **Solid fuel problematical**—Which solid fuel to use poses a third serious question. Liquid fuels, with their high heating capacity, complexity and cost, must be compared with the solids. But the basic choice rests with that propellant which provides an optimum combination of high burning temperature, maximum gaseous products and high gas specific heat.

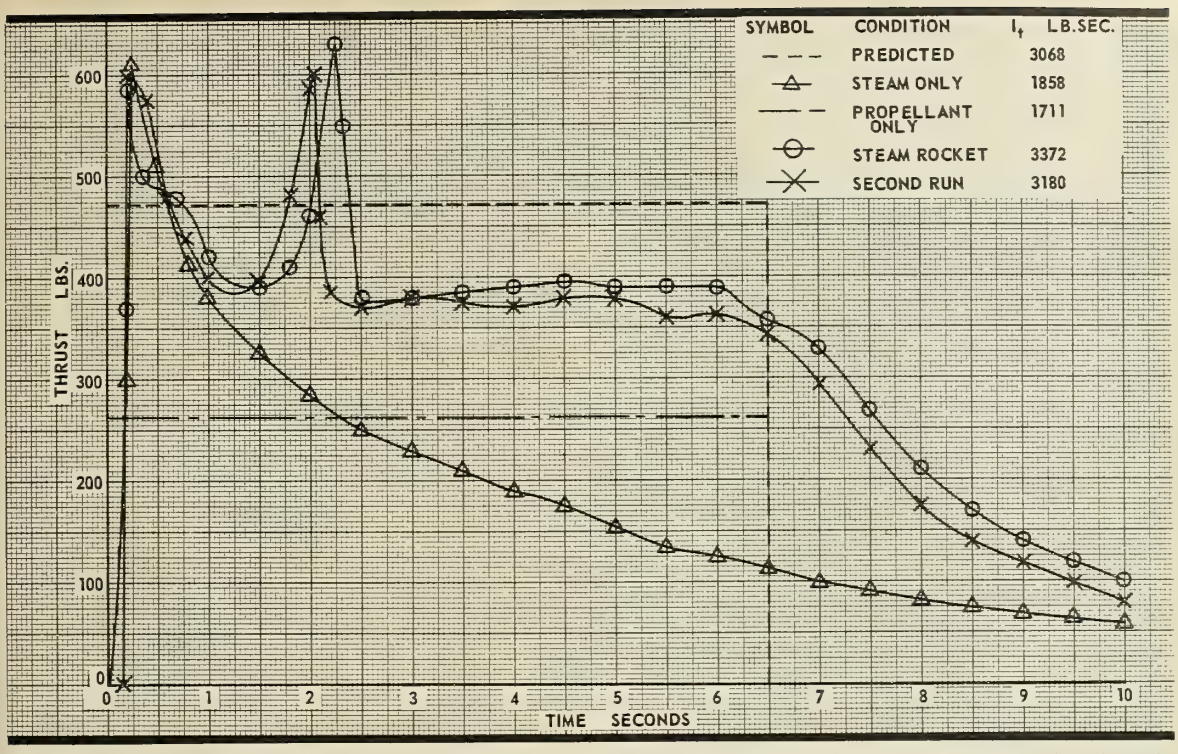
Some experimental work is necessary to obtain data in these areas, and specific programs have been outlined by Haas. These problem areas are only part of what Haas calls "Phase I." Other sections cover parametric studies in the relationships between propulsion parameters and aerodynamic characteristics.

Mission design studies form a third part of the initial development steps toward production steam rockets. Fairchild's planning scheme calls for an approved program plan available 20 weeks after initiation of Phase I and leading into the development and fabrication of a single-stage steam-powered sounding rocket sized for a particular mission.

The rocket itself would probably consist of a filament-wound glass fiber case designed to hold 2000 psi water at 650°F, a simple aluminum or molded reinforced plastic nozzle, and a standpipe—concentric with the case and leading from the top to the nozzle, insuring

*HORIZONTAL EXHAUST method simplified the test apparatus design during steam rocket firings. The water was heated in the unit with fuel contained in heavy walled structure at base of pressure vessel.*






*THRUST-TIME histories show a drop from predicted level in the steam/propellant firings. Predicted line assumed all heat from the propellant going to the water-steam conversion. In the first two firings, propellant heat actually went to raise water temperature to the boiling point. Even with these and other losses, both runs came within 12% of the total impulse of the propellant-only and steam-only curves together. Fairchild is confident these initial losses can be corrected through design.*

a maximum water-steam conversion before nozzle ejection. All these are inexpensive.

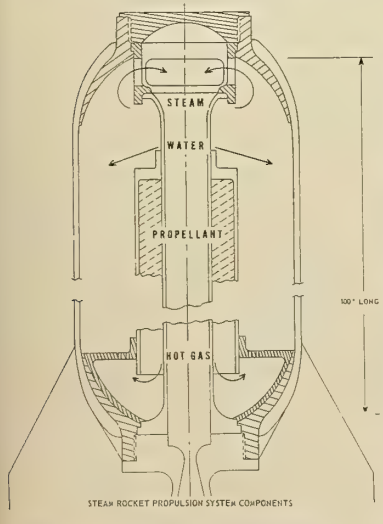
Final materials selection depends on results of the first phase studies, but preliminary work provides some ground for reasonable assumptions.

The glass filament-wound motor case approach appeals to Fairchild for a number of reasons. Strength-to-weight characteristics are equal or better than those of the best high-strength steel and titanium alloys. Notch sensitivity is eliminated.

In addition, the fabrication costs of both metals are high, and the raw material cost of titanium has its disadvantages. The structure must be a good thermal insulator and the low conductivity of glass-epoxy combinations fits this requirement perfectly.

Wet-strength problems associated with filament-wound glass fiber structures present no difficulties since a butyl or buna rubber liner will be used. No protective finish is needed. Reinforced plastic cases avoid the expensive manufacturing operations associated with metal structures.

The case is likely to have a wall thickness of 0.15 in. to withstand a design pressure of 3000 psi. The aft end of the motor bottle will require a molded phenolic-asbestos liner. This insulation will have to reverse the flow of the hot propellant gases and direct it up through the water supply. The standpipe could also utilize glass fiber construction.




STEAM ROCKET PROPULSION SYSTEM COMPONENTS

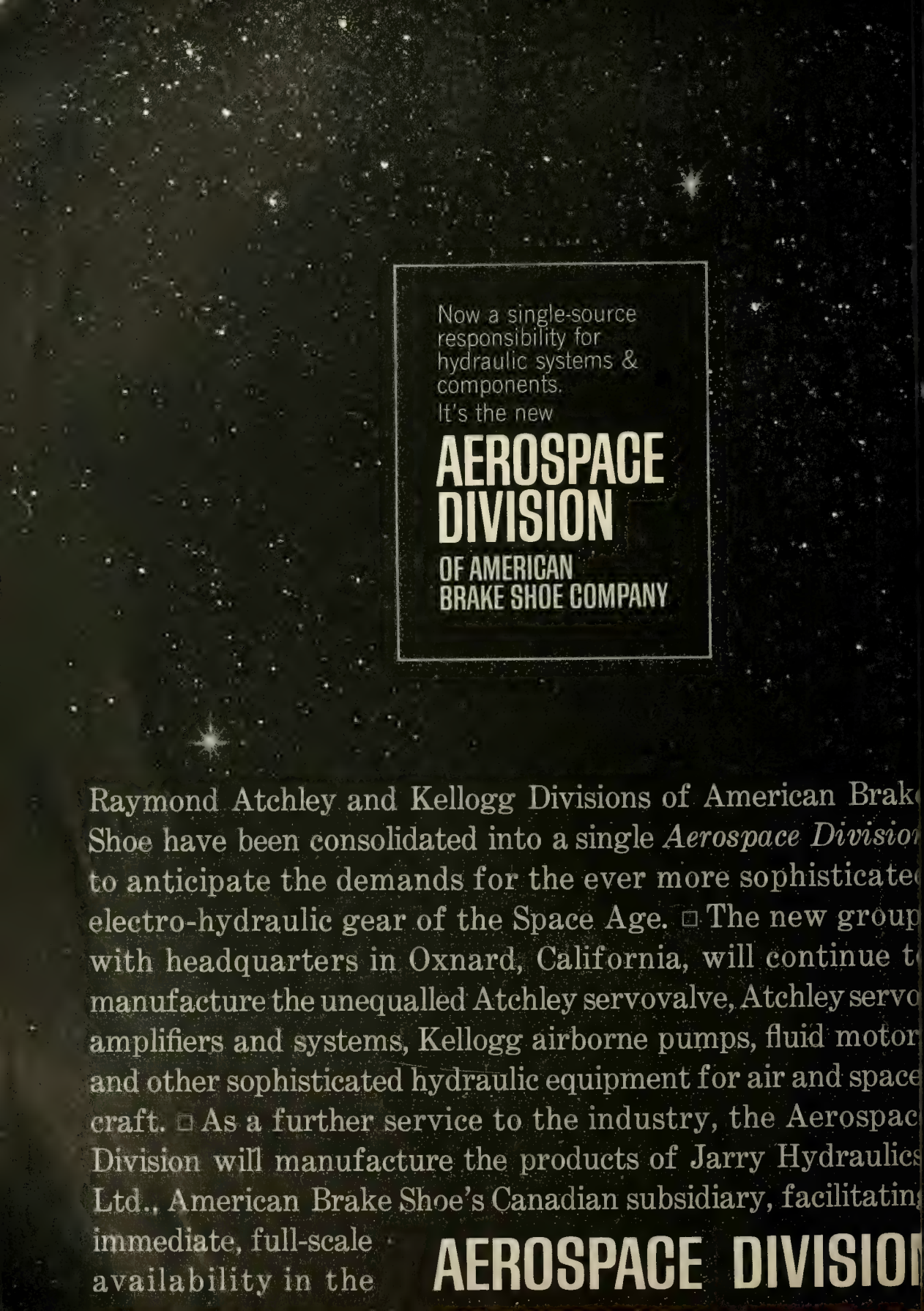
*STEAM ROCKET operation basically converts water to steam, exhausts vapor through center standpipe, providing thrust.*

The fuel must have an inverse burning rate at the design pressure in order to achieve reaction stability. The grain can either be cast or case-bonded in place. Grain and igniter will be threaded to the aft boss, and the nozzle threaded to the standpipe adapter.

The rocket could be made recoverable or designed for one-shot applications amenable to congested areas. It could be so standardized for the latter that airports might find it economical and safe enough for daily weather sounding purposes.

• **GSE factor**—The ground equipment is simple and reusable. The most expensive single item would be a boiler capable of supplying the 635°F/2000 psi water to the rocket. Other equipment might include a launch tube with a bore rider to impart initial velocity and direction, electrical ignition devices and pumps. The cost of these, high in comparison to a single firing, will be reduced substantially when amortized over a number of launches. The equipment would be transportable.

Fairchild has proved the concept feasibility and demonstrated some repeatability in the firing tests. The firm is now investigating the possibility of government support for the two-phase development program. ⌗


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# AMERICAN BRAKE SHOE COMPANY

# New Telemetry Studied for Saturn

by Arthur H. Collins

GOLETA, CALIF. — A completely transistorized, 30-channel multiplexer and signal conditioner is being evaluated at NASA's Marshall Space Flight Center for possible use in the *Saturn* program.

The solid-state device, designed and built at Servomechanisms, Inc.'s research and development center, acts as a commutator and signal conditioner for 26 sensor inputs, plus two reference voltage channels and two channels for the Inter-Range Instrumentation Group (IRIG) pulse format used for decommutation.

Possible system application would include all areas of *Saturn* flight operations from which telemetry data is required. A multiple installation would be required, however, to handle the some 400 points from which NASA will probably need data.

The SMI multiplexer uses a single time-shared, variable-gain amplifier to replace 30 individual channel amplifiers. A 300-cps ring counter is used as a program sequencer to supply data outputs at a 10 sample-per-channel-per-second rate. Use of break-before-make switching eliminates normal switching noise.

In operation, an interrogation pulse from the ring counter is sent through an "AND" circuit to the gate of the sensor data channel to be sampled. If the sensor is producing data, that signal and the ring counter pulse form a coincidence pulse that triggers the gate, thus passing sensor information to the master amplifier.

The sensor data is amplified and coupled to a telemetry system for transmission to the ground recording equipment. If the sensor is not producing a signal, coincidence fails to occur and the program sequencer moves on to interrogate the next channel.

• **Signal conditioning** — All sensor signal conditioning is accomplished within the system.

Automatic Temperature Compensation (ATC) circuits provide signal conditioning for thermocouples and upper atmospheric temperature probes. Temperature compensation range is from 0 to 90°C ± 3°.

Frequency converters are provided for FM instrumentation and dielectric constant measuring sensors. The converters have adjustable frequency ranges of 200 to 3000 cps for full scale output of 5 volts dc. Minimum acceptable input signal level to this conditioner is 100 mv with circuit linearity of 0.1%.

Demodulator signal conditioning circuits accept sensor input levels from 0 to 500 millivolts with impedance values of 50 K ohms (at 400 cps). Demodular frequency range is from 400 to 2000 cps with linearity of 0.1%. This type of signal conditioning is best suited for pressure measuring sensors used in tanking and fuel monitoring.

Signal conditioning for resistance probe inputs are one leg of a Wheatstone-type bridge built of 0.1% precision resistors. The bridge has both excitation and zero adjustments capability.

A wire-wound scaling pot is available for inputs needing this type of conditioning. Resistance values from 0 to 100 K ohms are available.

The multiplexer's current configuration is not the ultimate in packaging. NASA required the prototype system be packaged in four NASA-supplied "standard aerospace boxes" (6 x 8 x 11 in.). SMI engineers say that a reduction in size by a factor of four is possible using current state-of-the-art techniques, and they could supply the entire system in a package one-fourth the size of a single NASA-supplied box.

In the current design, interchangeable printed circuit cards are used throughout. There is no heating problem due to the surplus of available space. Clamping circuits are used throughout to prevent cross-talk between channels.

• **Timing**—Master timing for the system is obtained from a 2 kc system clock feeding a series of frequency dividers. The clock signal is sent directly to an isolation driver circuit, which outputs a 1200-cps signal to a flip-flop. The f/f output of 600 cps is again divided in half and sent to the ring counter. This 300 cps pulse provides the timing pulse for the ring counter starting sequence which, in turn, interrogates the 30 channels at a 10 samples-per-channel-per-second rate.

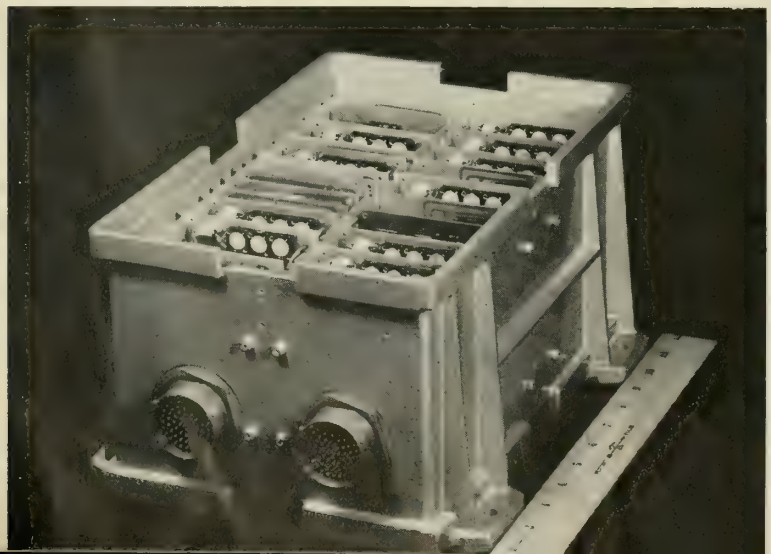
The multiplexer will accept low level inputs from 5 mv to 50 mv. High level inputs are accepted from 0.05 to 0.5 volts.

The master amplifier has a selectable gain characteristic of 10, 100 and 1000 with respective impedances of 1 Meg, 100 K and 10 K. Signal source impedances are from 0 to 10 K.

System power supply takes 28 volts from the vehicle's power system and outputs 17 and 6 volts dc for circuit operation. Isolation power supplies are available for sensors requiring isolation voltages.

The PAM-IRIG standards serve as output telemetry signal format, with output voltages of 0 to 5 volts dc and output impedances to the telemetry transmitter of 200 ohms. ⁂

*SOLID-STATE multiplexer is packaged in four NASA-supplied 'standard aerospace' boxes like this one. Space conservation was not a design problem for Servomechanisms, Inc. engineers.*






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# Lineless 'Drawings' Aid Titan Work

***New Martin approach shaves costs, manhours in preparing electrical circuitry instructions***

**by Charles D. LaFond**

DENVER—Lineless "drawings" prepared by standard IBM punched-card equipment have greatly reduced time and costs in preparing electrical interconnection instructions required at *Titan* test stands and at *Titan* ICBM bases.

The approach was developed here by E. R. Nelson, senior program planner at Martin Co., the Aerospace Division of Martin Marietta Corp., in a highly successful attempt to reduce the thousands of wiring diagrams previously issued to Martin field crews and installation subcontractors.

Engineering manhours spent on non-creative drafting detail have been cut in half, Nelson told M/R, by machine-produced alpha-numeric "blueprints." So impressive have been the results to date from employing a machine approach that Martin personnel here are considering extending the approach to cable routing, wire-size and voltage-drop calculations, besides bundle, terminal and wire number assignments.

At a typical test stand, circuitry is required to connect the umbilical tower, the missile, a central room, and numerous test monitoring systems through some 60 mi. of wiring selected from 600 possible cable configurations. Also, said Martin engineers, technicians must terminate some 40,000 individual wires (80,000 terminations) before test personnel can control the missile under test and simultaneously capture data during a firing.

The machine-printed "drawings," which are actually sequential lists of wires and cables, spell out specific identification, routing, function, voltage drop, end-points and methods of terminating each wire and bundle of wires within each complete circuit.

• **Changes are problem**—A release package for a single interconnection setup thus becomes a major job, and because of constantly changing circuitry, the cataloging task is enormous, said Nelson. Each test stand tests various missile modifications, each requiring its own interconnection engineering.

For single test stands, the company anticipates as many as 120 separate interconnection setups. Moreover, engineers here have the problem of rapidly incorporating changes into release drawings.

The old method was to lay out interconnection engineering for each modification at each stand, then give the original drawings to draftsmen who prepared them for reproduction. A single interconnection setup required up to 3000 such sheets of unwieldy 18 x 48-in. paper.

This was a costly and time-consuming operation. On occasion, Nelson asserted, this procedure has delayed missile testing when engineers received interconnection data for a missile modification too late to provide adequate drafting lead time.

Recognition that most of this engineering—and all of the drafting—was repetitious and non-creative, led to the decision to automate. Although engineers were producing original drawings, they actually were stringing together standard components in more or less pre-established ways, said Nelson.

Thus, it was suggested that all wiring and components could be cataloged and an automatic system developed to produce "drawings." Moreover, such drawings could be produced from standard IBM punch-card equipment and could be made to satisfy engineers and field installation requirements equally well.

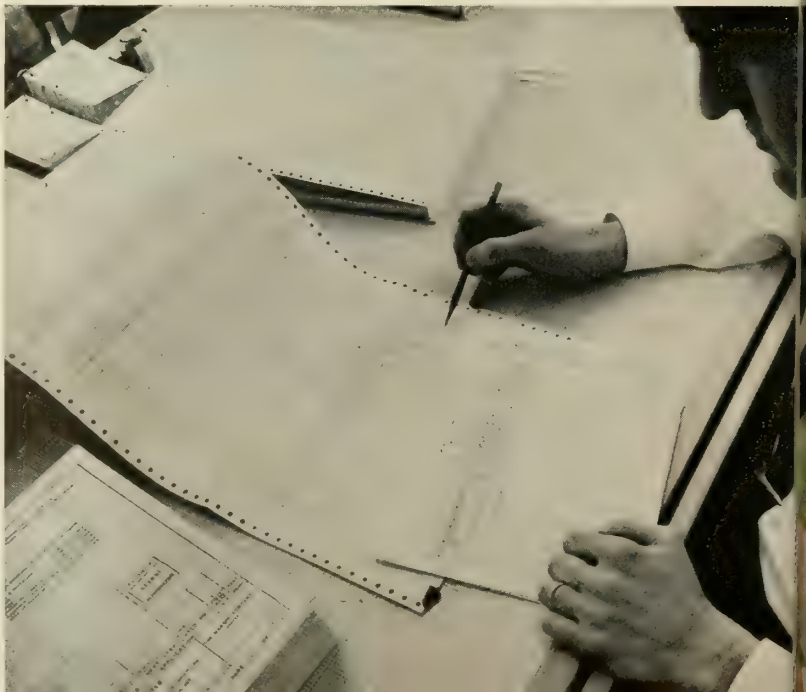
• **Decoding minimized** — Nelson pointed out that the coding necessary to convert engineering data to the language of automation was developed in a manner that would minimize the need to decode or translate information in the field. The drawings thus produced by the IBM equipment were expressed in standard trade terminology.

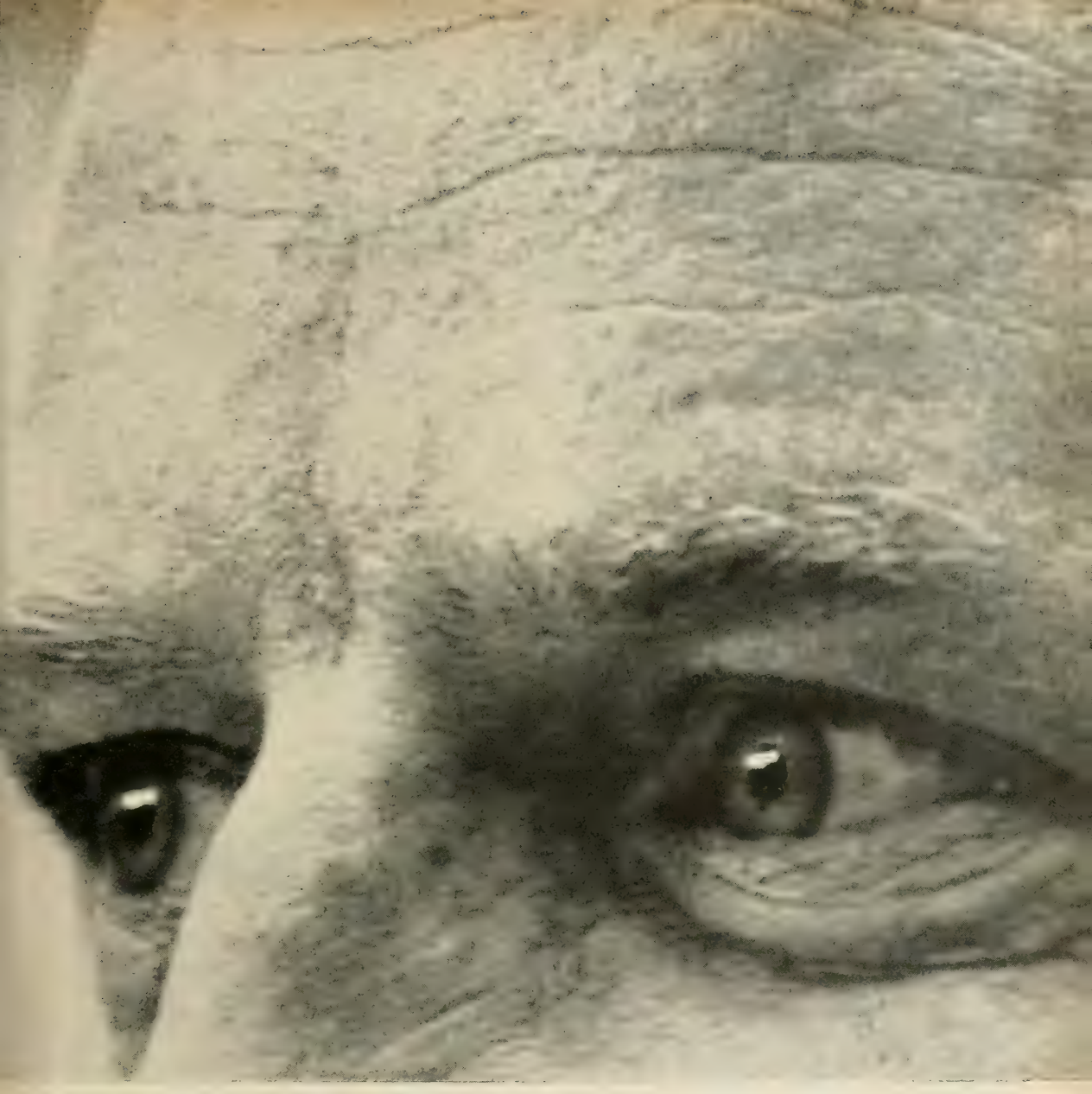
Once the coding was developed, the rest was a matter of mechanics. Now, project engineers first lay out the interconnection engineering, then express their drawings in code on special sheets. Operators next punch this data into cards.

The preparation of drawings then becomes a gross tabulation effort on IBM account machines. These print the drawings on special paper for multilith reproduction. Instead of the former 3000 drawings, complete instructions are reduced to some 200 printed 8½ x 11-in. sheets.

While there are five separate sec-

*ENGINEER 'CODING' interconnection data for incorportion into EAM drawings. Engineering changes are made directly on IBM tab listings while new input is coded on special forms.*





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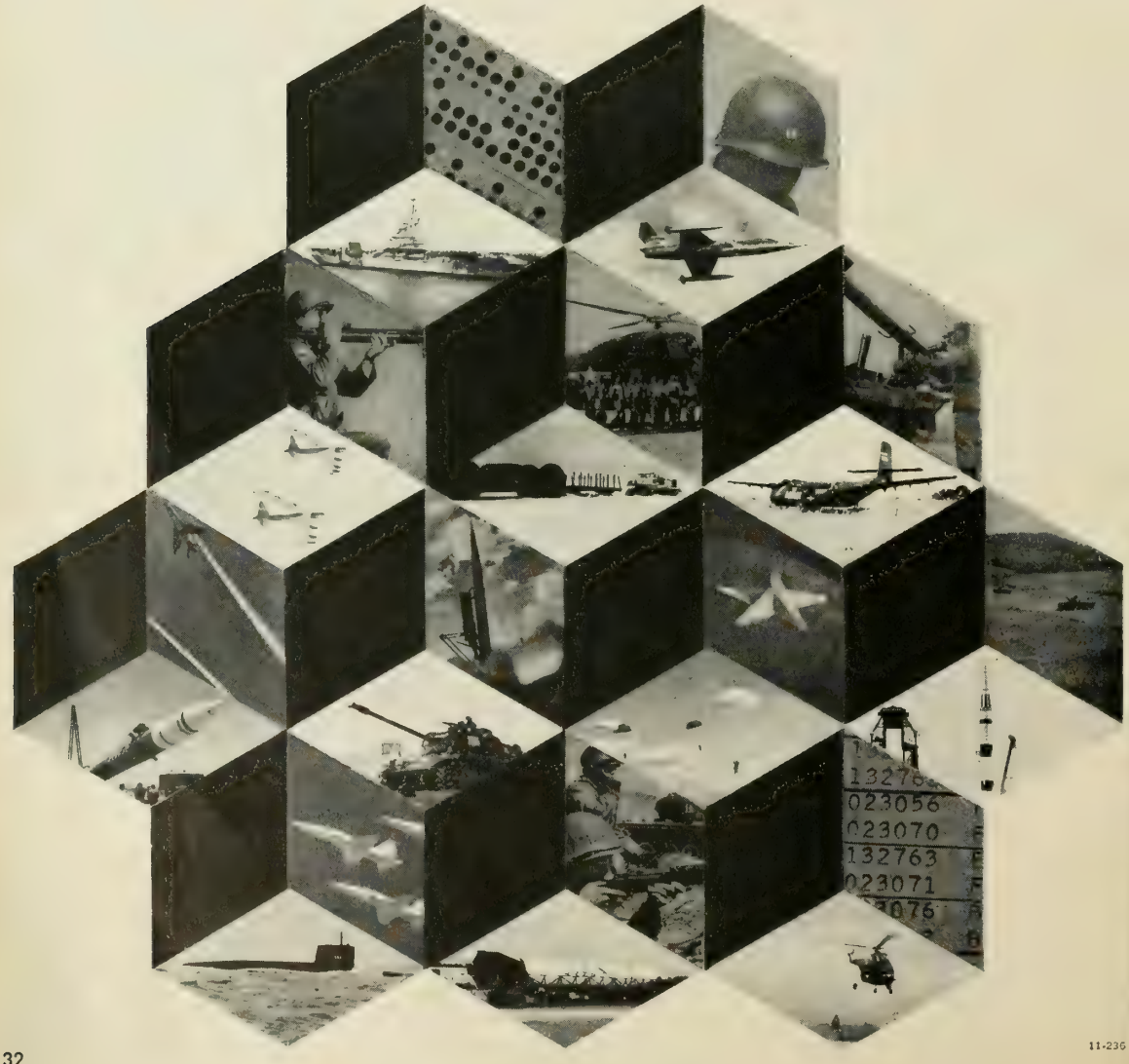
*The information behind such decisions is incredibly complex. In volume, in variables, in interrelationships. And each decision itself may affect world-wide or continental forces and events. In making operational decisions, today's commanders and governmental leaders use systems which provide information processing assistance. Developing these huge man-machine systems is the work of scientists, engineers, and computer programmers at System Development Corporation. Their concern is system development, not hardware development. They consider the interaction and effect of men, doctrine, tradition, training; of organizations, chains-of-command and chains-of-succession; of communications, traffic centers, command posts, computers and displays. Their work begins with system analysis. It continues through system synthesis, computer instruction, system training, system evaluation—and then in adapting the system to the changing needs of its users. Throughout they strive to optimize man-computer relationships and also carry on research into future systems. Human Factors Scientists, Operations Research Scientists, Systems-Oriented Engineers and Computer Programmers interested in joining this expanding field are invited to write Dr. H. A. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."*

**SDC**

*Systems that help men make decisions and exercise control*

**System Development Corporation**

## Decision-Making: Direction of Forces—What, Where, When?






11-236

## ıeless 'Drawings'

(Continued from page 30)

majority of information needed in tallation and maintenance of wiring tems is included in two major tions:

(1) *A Continuity Run*, which de- ts all wire segments necessary to mplete a circuit. This section is used insure correct end-to-end termina- ns.

(2) *A Bundle Termination Section*, hich gives exact termination data for ch wire in each cable.

After a release package is prepared, e IBM cards are filed. When changes e made, it is only necessary to sort ıt affected cards and replace them with ew ones. Also, sheets in use in the eld affected by the changes are re-run nd distributed.

• **Eliminating errors**—With volume igh, it is easy to make errors that are kely to remain undetected. By mech- nizing the drafting operation, Nelson eels the most costly and error-prone ork has been eliminated. Also, ma- hine-prepared listings are completely egible.

More important, however, is the ime saving, both in manhours and elapsed time.

During one three-month period, he said drawings were released for 10 different test stand configurations. In contrast, when the manual system was used, no more than two similar simultaneous stand configurations could be produced in a comparable period.

In the same three-month period, moreover, 55 basic and 176 revision packages were processed, company records show.

Another gain is in the lead time needed to produce and release drawings. This has been chopped from three months to approximately six weeks with the automated system. In addition, the number of people tied up in interconnect engineering has been reduced.

• **Accuracy saves times**—Increased accuracy resulting from the machine system has appreciably reduced the kind of problems requiring contractors and subcontractors to call on Martin/Denver's liaison engineers for help. For example, during a lot modification performed before introduction of the automated procedures, 532 liaison calls (clarification requests) came in from the field. On a comparable lot after automating, the number of liaison calls was reduced to 250. Subsequent modifications have reduced this figure even further.

In addition to having time for con-

(Continued on page 40)


## Norair needs men with penetrating minds

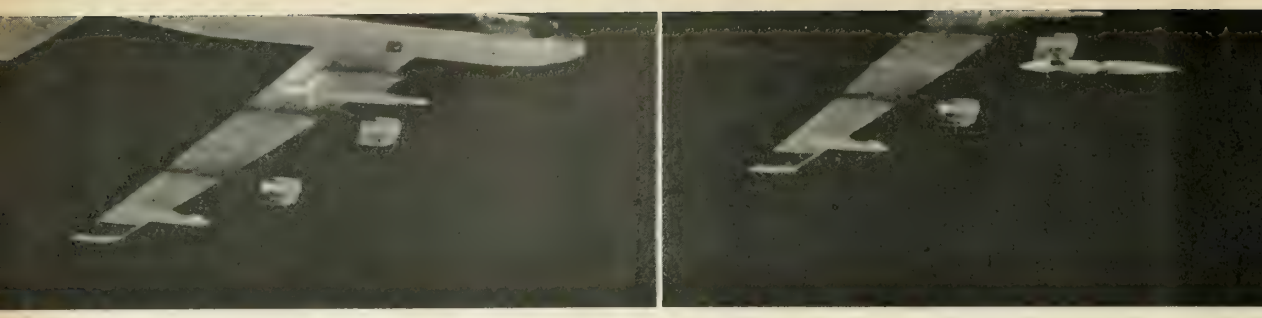


The men we're looking for will tackle many tough problems. Solutions won't come easy. But they'll find them. They have the kind of minds that aren't easily thwarted. If you're of this turn of mind, why not get in touch with us? With new areas of investigation and research constantly challenging us, we need hard-working dreamers to bring them into focus. These positions are available now:

**Engineers** in electronic checkout systems who have worked with advanced design and program development.
**Engineers** whose background is in supersonic aerodynamics, stability and control, inlet design, ducting, and performance analysis.
**Engineers** familiar with airframe structural analysis.
**Scientists** specializing in infrared, optics, and electronic research.
**Engineers** to work in data reduction.
**Scientists** who know structures research and dynamics.
**Scientists** who have done supersonic aerodynamic research.
**Scientists** experienced in working with information and sensing systems, platforms, infrared, sensors, flight controls, airborne computing and data handling systems.
**Engineers** familiar with programming, operations, and instrumentation for ballistic missile flight test.
**Reliability Engineers** to assess the reliability and to optimize the configurations and mission profiles of space systems.
**Chemical Engineers** to work on the development and applications of structural adhesives for aerospace vehicles.
**Metallurgical Engineers** for research and development on materials and joining.

If you'd like more information about these opportunities and others that may be available by the time you read this, write and tell us about yourself. Contact Roy L. Pool, Engineering Center Personnel Office, 1001 East Broadway, Hawthorne, California.

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management

# Air Proving Ground Emphasis Shifts to Space Operations

***Electronic capabilities expand at Elgin as conventional missile tests continue***

**By James Trainor**

EGLIN AFB, FLA.—New emphasis on space operations and electronic testing today is overshadowing more conventional aircraft and missile test programs at Air Force System Command's Air Proving Ground.

The Center still is deeply involved in testing *Hound Dog, Skybolt, Bullpup, Quail* and other missile systems. But it already has proved its new space capability with unique contributions to Project *Mercury* and by an extensive space probe program.

Its tracking capability will be expanded by the addition of a huge phased array radar for detection and tracking of satellites. To be developed by the Radio Div., Bendix Corp., the new radar is to be ready for test in the spring of 1964. It ultimately will become an integral part of North American Air Defense Command's SPADATS (Space Detection and Tracking System). APGC expects to provide sector coverage for one part of a global surveillance and tracking system.

• **Space probe program**—Largest immediate area of expansion lies in APGC's space probe program. This has grown from 25 launches in 1959 to a planned 243 firings this year. The total is expected to jump to 300 in 1963, 360 in 1964, and finally to 420 in 1965.

Most of the rocket launchings from APGS's Santa Rosa Island facilities are to provide measurements in one of three areas: the space environment as it naturally exists, the effects of efforts to change or use this environment, and component tests of space systems.

The current APGC launch program is concentrated in the first area. More than 130 *Arcas* rockets will be launched this year to provide meteorological data and in an effort to evolve an operational meteorological rocket system for wide use.

APGC's present launch complex consists of one liquid *Aerobee* tower, single solid propellant pads for *Cree* and *Loki* and two for *Arcas*. There also are two general purpose pads. In addition, some *Bomarc* test facilities now are being made available for space probe modification.

Unlike space probe facilities at NASA's Wallops Island, the APGC facilities are used exclusively to support work under Air Force contract. Most launches support projects of the AF Cambridge Research Laboratories.



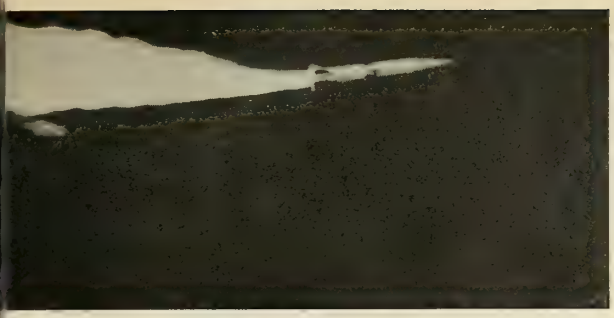
**Maj. Gen. James E. Roberts**

When modification of the *Bomarc* facility is completed, the Center will be able to handle vehicles as large as *Blue Scout*. Largest vehicles to be launched under present plans, however, are *Trailblazer II* and *Genie* configurations.

Another new capability for the space probe program will be that of remote launches. Probes will be fired from a modified *Sergeant* launcher back toward the densely instrumented Eglin Main base from a number of points along the Florida coast. APGC also is building up its ability to provide anything from launching services to the design and integration of a complete payload package.

• **A unique combination**—To accomplish its basic mission of engineer-user testing of AF systems, the Air Proving Ground combines an 800-sq.-mi. land range with a 45,000-sq.-mi. Gulf test range. The latter extends from Eglin on the northwest coast of Florida to Key West, 450 miles away. Unlike Cape Canaveral, which is essentially a line range, Eglin Gulf Test Range provides an area range some 100 miles wide.

Instrumentation for the Gulf range is provided by a series of tracking and telemetry stations stretching from the main Eglin complex to Key West. The range control center at Eglin contains the major control consoles, range safety



*First live firing of Skybolt ALBM from B-52 over Cape Canaveral.*

facilities, phototheodolites, three AN/FPS-16, C-band radars and range communications facilities.

On Santa Rosa Island—a sandy spit running parallel to the Florida coast opposite Eglin Main—are the missile launching, central telemetering, frequency monitoring and drone control facilities. The latter two complexes are equipped with range, azimuth and elevation-determining AN/MPS-9 radars, command guidance systems, missile and drone telemetering stations and range communications. The launch complex provides a beacon check, telemetering checkout and timing countdown for missile firings.

Of the four downrange stations located along the crescent of Florida's Gulf coast, three have identical tracking and telemetry equipment. The fourth at Key West, presently not being utilized, is maintained in caretaker status. The three active stations at Cape San Blas, Anclote and Marco Island each has three AN/FPS-16, two AN/MPS-9 and one AN/MPQ-31 radars as well as three missile and three drone telemetering and command guidance systems. The Key West station—not as elaborately equipped as the others—has only an S-band AN/MPS-9 and one AN/MPQ-31 radar, two missile and two drone telemetering systems and three command guidance systems.

The primary reason for the density of range instrumentation, APGC officials explain, is that the range was designed to handle three simultaneous *Bomarc* launches against three high-speed drones.

Range communications are provided by a combination of microwave links between the range control center and Cape San Blas and between San Marco and Anclote, and tropospheric scatter between Cape San Blas and Anclote and between San Marco and Key West. Direct lines link Eglin with Cape Canaveral, the Air Force tracking center at Sunnyvale, Calif. and NASA's Goddard Space Flight Center.

Secondary data for acquisition of either a missile or drone is handed off downrange from one station to the next while primary test data flows in the reverse direction. With 400 telephone pairs linking the San Blas station with Eglin Main, the Center can achieve a real time capability by feeding downrange data directly into its 7090 data processor. Normally, however, only impact prediction is made in real time; other data are usually stored on tape before processing.

Eglin is Station 17 in the *Mercury* tracking network and NASA will not permit an astronaut launch unless Eglin is ready. Initially, NASA did not feel the Eglin station was mandatory. Eglin proved its worth, however, by providing precise information on the critical re-entry phase of *Mercury* and handing the data off over live data circuits to the Cape and to Goddard for processing. Eglin tracking facilities have considerably increased the accuracy of *Mercury* impact predictions.

• **Category Testing**—The fundamental purpose of this vast array of tracking and telemetering equipment, however, is to test the technical and operational suitability of weapons systems for the Air Force. In accordance with AF regulations, these tests are divided into three categories:

—Category 1: Contractor systems test, to assure the contractor he has met contract specifications. Contractor personnel run this phase with minimum AF interference.

—Category 2: AF Systems Command Test, to spot-check the contractor tests for assurance that technical specifications have been met. AF technicians run these tests with a small contractor crew standing by.

—Category 3: User agency tests to insure that the equipment will perform adequately in the field.

Annual operating cost of the Air Proving Ground Center is only $78.1 million. This does not, however, indicate the scope or value of the testing program. A more valid criterion would be the value of the nine major systems under test—including the F-105D, *Bomarc A & B, Quail, Hound Dog, Skybolt,* B-52 ECM, *Bullpup* and electronic

## How to Sell to APGC

Both base and R&D procurement of the Air Proving Ground Center is handled through a single office which maintains its own source list. To get on the list, a potential contractor must send a letter to the Deputy for Procurement, Air Proving Ground Center, Eglin AFB, Fla., asking for the necessary forms and listing the contractor's capabilities.

APGC officials point out that only a limited number of firms is asked to prepare proposals on a contract, the exact number depending on contract size. They also note that the prime consideration in awarding contracts is not necessarily price but technical evaluation of a proposal.

Main areas of procurement at APGC at present are: tow targets, scorers, explosives, microwave switches, bomb ballistic studies, infrared and antenna subsystems, signal transmitters and frequency measurement equipment.

## Targets, Exotic Weapons

Aeronautical Systems Division's Directorate of Target and Armament Development (Detachment #4) has a two-fold mission as one of the Air Proving Ground Center's principal tenants:

• It is responsible for design, development, evaluation and standardization of Air Force targets and drones for AF use, and also handles scorers, infrared and radar augmenters associated with these systems.

• It conducts basic and applied research and operational support development programs which cover biological, chemical and directed-energy weapons (lasers and masers).

Detachment #4 has an approved FY '63 R&D budget of approximately $25 million. Part of some 45 research projects are contracted out to industry. The detachment has about 50 contractors, including Minneapolis-Honeywell, Aerojet, Thiokol, GE, North American, Raytheon and Goodrich High-Voltage Astronautics.

Current programs of the Target Development Laboratory include supersonic tow targets for interceptor air-to-air missile firings. Applied research includes study of advanced IR sources, techniques for establishing the vector miss distance of anti-satellite and anti-ICBM weapon systems, and methods of sensing the damage caused to a target by a kill mechanism.



*MOBILE LAUNCHER gives APGC unique capability for remote launch of space probes. Launcher is modified from a Sergeant vehicle; probe is an Exos.*

systems tests. The total national investment in these systems, excluding production costs, is more than $9 billion. Test costs total $528 million, $390 million in contract dollars and $138 million in AF support costs.

To support an operation of this magnitude, some 5000 military and 1916 contractor personnel are assigned to APGC. Over 900 Vitro Service Corp. representatives run the range for the Air Force. However, unlike other contractor-run ranges, Vitro is responsible only for operating the radars and collecting data. Air Force analyzes the data.

• **Organization breakdown**—Organizationally, APGC is divided into six separate areas: aircraft and missile tests, aerospace, electronic systems test, bioastronautics, foreign technology and procurement. Each is headed by a deputy who reports directly to the APGC Commander—Maj. Gen. James E. Roberts—for activity support.

Under each of the first three deputies, there are organized joint test teams —comprised of both the developing and using agencies and responsible for category testing of a particular system.

The test team derives its support from APGC but is responsible to the system program officer at the major AFSC development agency.

A deviation from this system is the joint test team for the GAM-87 *Skybolt*. Because of the importance of this system, the team which normally would have fallen under the cognizance of the deputy for aircraft/missile test is separately organized on a par with the deputies.

• **Missile Tests**—Missiles currently under test at APGC include the GAM-72 *(Quail)*, the GAM-77A *(Hound Dog)* and the GAM-83B *(Bullpup)*. The first two are being tested for SAC use while the latter is programmed for TAC.

Although initial testing on the three systems has been completed, follow-on work is still necessary on all but *Bullpup*. Category 2 testing is under way on the improved version of the *Quail* to determine its additional capability over GAM-72A.

For the first time, *Hound Dog* is undergoing a true "blue suit" test to determine if the Air Force can maintain and use the system in the field. The tests, which still have a year to run, are also aimed at proving the changes and fixes introduced into the improved GAM-77A. Complicating this test program is the fact that *Hound Dog* has to be tested at both the Holloman AFB land range and Eglin over water range.

APGC also tested the nuclear GAM-83B and the TGAM-83 training missile to determine their suitability to Air Force requirements.

## AF Lacks Skybolt Test Personnel

Lack of trained Air Force personnel to conduct forthcoming Category 2 *Skybolt* tests is a major problem now confronting the Eglin AFB Joint Test Force. AF officials say Category 2 testing may need greater contractor support than usual. Cause of the problem is a training hardware shortage that will force AF technicians to train with theoretical and early-design models.

Until training hardware is available next July, Air Force personnel will be instructed in Douglas Aircraft Co.'s *Skybolt* plant. After a four-month training program, they will be integrated with the contractor's Category 1 test team for on-the-job training. Douglas personnel may initially make up as much as one-third of the Category 2 test team.

The British Joint Trial Force, under Wing Commander Charles E. Ness, will be considerably larger than the 165-man U.S. test contingent, mainly because maintenance of *Skybolt*-carrying *Vulcan* bombers is integral to Joint Trials under the British concept. Cmdr. Ness says the Trial Force will reach a maximum strength of 300 RAF and Ministry of Aviation personnel by early 1963. Two *Vulcans* now under captive mechanical tests in England will be flight-tested at Eglin by next February.

In contrast to U.S. engineer-user testing, the British force will evolve and evaluate not only technical suitability and maintenance procedures for the *Vulcan-Skybolt*, but also tactical concepts for Bomber Command use of the new system.

The British may buy some *Skybolt* ground equipment from Douglas for the test program, though British operational equipment will be used when possible.




Today, the design and development of space systems, vehicles and weapon systems is achieving an even greater degree of importance than before. Expenditures are increasing. The pace is being stepped up.

Hughes Aerospace Divisions are expanding with each of these progressions. Important projects such as SURVEYOR, SYNCOM, advanced POLARIS guidance and Anti-ballistic Missile Defense (boost-intercept, mid-course, terminal) are now underway. Others will begin soon. This expansion is producing new, challenging assignments which never existed before. You can now be a part of, and benefit from, Hughes further expansion into the space age.

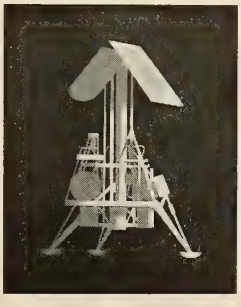
If you hold a degree from an accredited university in Mechanical Engineering, Electronic Engineering or Physics, are a U. S. citizen and have experience or interests related to Aerospace Vehicles or Weapon Systems, you can qualify. A few of the openings include:

**controls engineers**
Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, controls systems, control techniques, transistorized equalization networks and control servomechanisms.

**circuit designers**
Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

**systems analysts**
To consider such basic problems as the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

**infrared specialists**
To perform systems analysis and preliminary design in infrared activities involving satellite detection and identification, air-to-air missiles, AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.



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## Air Proving Ground

(Continued from page 38)

• **Electronic systems test**—One of the most important and growing areas of systems testing covers Electronic-Countermeasures and Electronic-Counter-Countermeasures. Eglin provides over 20 radars covering the whole frequency spectrum for ECM and ECCM testing. In addition, an arrangement with the Montgomery sector of the Air Defense Command enables Eglin to test ECM packages by flying them in from the Gulf against ADC defenses.

Currently, category testing of a new family of high-power Frequency Diversity Radars is nearing completion, with the end of the tests scheduled for November. After test, these new surveillance radars will be turned over to ADC for installation into the SAGE system. Production costs for the FD radars is estimated at $700 million or about $3-5 million per copy.

The family of FD radars includes: AN/FPS-24 surveillance radar from General Electric, AN/FPS-26 height finder radar from the Crosley Div. of AVCO, AN/FPS-27 3-D surveillance radar from Westinghouse and AN/FPS-35 surveillance radar from Sperry Gyroscope. Another radar—Raytheon's AN/FPS-28—has been dropped from the FD family and is now being used as a victim radar for ECM.

Frequency Diversity Radars operate on the principle that it is much more difficult to jam air defenses if the surveillance radars are able to switch frequencies quickly and over a wide range. Thus, if two radars operating on widely separated frequencies—each able to switch quickly over a wide frequency band—are observing the same air defense sector, the ECM problem becomes almost prohibitive because of the wide frequency band which must be jammed.

Providing a foil for ECCM testing as well as a means of evaluating and improving electronic equipment is APGC's work on EMC. In this area, B-52H/*Quail* ECM system testing is the main item of business for the next few years. APGC is component testing individual black boxes by flying the aircraft in from the Gulf against "victim" radars.

Eglin's tracking facilities provide invaluable space-time information on the aircraft which, in turn provides data on the effectiveness of individual ECM techniques. No other range, APGC officials say, has this capability. ⁂


## Opportunities at General Atomic for Engineers and Scientists

General Atomic Division of General Dynamics has immediate openings for engineers and scientists, including positions in an advanced program to develop a new propulsion mechanism for large space vehicles. This dramatic program involves the use of controlled nuclear pulses to propel large vehicles such as a space platform of 1000 tons or more.

This is one of many expanding programs at General Atomic's John Jay Hopkins Laboratory in San Diego, the world's largest privately-owned center of diversified nuclear development. Other major projects include high temperature gas-cooled reactors for electric power generation . . . beryllium-oxide moderated gas-cooled reactors . . . thermionic and thermoelectric systems for the direct conversion of heat to electricity . . . controlled thermonuclear research . . . and many other projects in physics, chemistry, metallurgy and engineering.

Although these programs involve work in many new areas of science and engineering, present openings can best be filled by men having experience in the following areas:

**TEST ENGINEERS** — Experience in one of the following related areas: testing of aircraft or spacecraft systems; test planning and scheduling; and instrumentation.

**GUIDANCE AND CONTROL SPECIALISTS** — Extensive experience in space trajectories, communications, telemetry, electromagnetic propagation, navigation and astronomy.

**DESIGN AND STRUCTURAL ENGINEERS** — Extensive experience in the design and development of space probe controls, sequencing, telemetering, and communications equipment. Structural engineers with experience in the design or analysis of structures capable of withstanding high impacts, and with capability of conducting wide scope development programs.

**THEORETICAL AND EXPERIMENTAL PHYSICISTS** — Solid state, plasma and nuclear physics research, and mathematical analysis. Multi-dimensional digital computing techniques. Fluid dynamics and radiation transport. Surface physics, hypervelocity impact studies, high altitude studies, semiconductor studies, advanced high explosive techniques, and shock tubes.

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## Lineless 'Drawings'

(Continued from page 35)

tractors, which eventually is paid for by Martin/Denver (and ultimately the government), substantial manhour savings were realized within the company because there were fewer calls to process field changes.

With easy-to-process cards in file (up to 80,000 for each test stand) full or partial listings of drawings are reproduced rapidly in any order desired. A 10% "safety factor" is provided for most circuits. In other words, systems are designed so that "spare" wires are available if needed.

Through machine sorting and printing, listings are prepared which show engineers exactly where these "spare" wires are located, and provide information that identifies them by type, function, length, and termination.

The system has great potential. Further development, Nelson stressed, is only a matter of time. The machines can quickly tabulate lists of all wires in a given area, print bills of material, provide lists for parts accountability, and produce lists for use when analyzing circuit activation-versus-even occurrence during countdowns.

Ultimately, he said, the job will be one for computer processing. By using magnetic tapes rather than cards as the basic medium for data storage, a computer system could be developed that would further increase processing speed and substantially add to flexibility. ⁂

# The Industry Week

## Small Business Trends

Military prime contract awards of $4.6 billion during FY '62 topped by nearly $1 billion the previous year's awards. The President in 1961 asked that defense procurement reflect increased participation by small business. Increase goals set then have been met, according to FY '62 figures. Defense plans call for even greater goals during the present fiscal year. . . . *Small business concerns across the nation received nearly 75% of all purchase orders issued by Douglas Aircraft Co. in the first seven months of the year. Nearly $60 million in Douglas purchases from almost 10,000 small business concerns for both military and commercial purchases marked a 20% gain over the same period of the year before, despite heavy Douglas commitments for projects and items that can only be awarded to larger firms.*

## New Industry Facilities

Aerojet-General Corp. has set up a functionally and physically independent rocket motor division in Sacramento, Calif., to handle development of small and intermediate solid rocket motor systems from the proposal and contracting stage through design and production. The new unit has its own production facility and a large headquarters building separate from the rest of the Aerojet plant. It is staffed by a 1250-man team experienced in the small-rocket field. Aerojet created the division to provide direct liaison with buyers and to facilitate faster decisions by slashing communications red tape. The company hopes to provide fully developed, qualified units in far less time and at less cost under the new system, and to become more competitive in the smaller rocket motor field. The new organizational setup is also expected to speed transition from R&D to production, and to eliminate problems of overlap with large rocket motor programs. . . . *October will mark completion of the first phase of a $2.3 million construction program to extend the major production and test facilities at North American Aviation, Inc.'s McGregor (Tex.) Solid Rocket Division AF Plant 66. Two pits for casting and curing of solid propellant rocket motors, two propellant mix buildings and a nondestructive test facility will be completed with the first phase. New facilities will double the division's processing capability, bringing annual production of high-energy castable propellant to 12 million lbs. Building the facilities are Warrior Constructors of Houston.* . . . Perkin-Elmer Corp. will build a precision optics facility at Vero Beach, Fla. Construction date has not been announced. The company said aerospace activity in Fla. and climate that would attract employees should facilitate expansion of production capability sufficiently to justify the new operation. . . . *Interchemical Corp. has begun construction of a 135,000-sq.-ft. research complex at Clifton, N.J. Completion of the center is expected within a year.* . . . Lockheed Propulsion Co.'s Potrero facility near Beaumont, Calif., has a new 25-million-electron-volt betatron that can X-ray through eight inches of steel with only 90-sec. exposure. Previous techniques required a two-day exposure. Despite its 25-MEV capability, the betatron is so versatile that it can be operated at as low as a two-MEV level, and can inspect rocket motors ranging from 10 to 156 in. in dia. Two-story housing for the betatron was designed by Quinton Engineers, Ltd., of Los Angeles. . . . *Philco Corp.'s TechRep Div. moved to Houston from Dallas recently. Aim is to effect closer liaison with NASA. The division will continue to serve the same territory in government, industrial and educational markets.* . . . Rantec Corp., Calabasas, Calif., has opened a new 22,000-sq.-ft. engineering and administrative center that provides for complete future interchange of lab and office configurations. Building design was by Charles Luckman Associates.

## Space Personnel Community Planned

Humble Oil and Refining Co. and Del E. Webb Corp. will build an $11-million residential and commercial community near the NASA Manned Space Flight Center near Houston. A motel, a school, model homes, offices and apartment buildings will be ready for arriving NASA personnel by next spring. A trailer park and a shopping center will also be open by then. Called Clear Lake City, the new community will occupy 15,000 acres and will grow to a population capacity of 140,000 by 1980, developers predict.

## Potpourri

The MB-3 propulsion system in the *Thor* intermediate-range ballistic missile has had more consecutive flight successes than any other U.S. high-thrust engine, according to the Rocketdyne Division of North American Aviation, Inc. MB-3 chalked up 100 launches in a row over a three-year period, including launches in which the propulsion system functioned as programed for duration of the flight even though the entire space mission might not have been achieved. By last August the *Thor* had launched 77 space vehicles—more than launched by any other U.S. missile. . . . *Webb & Knapp has begun drilling to determine construction problems at the site of the Washington Space Center in Washington. Excavation will begin shortly and completion is planned for November 1963. The center will include two eight-story, 250,000-sq.-ft. aviation and space office buildings, a communications building, and a 1000-room hotel. Buildings will be designed to meet security-clearance requirements and computer equipment weight loads. Occupancy—some of which has already been booked—will be limited largely to private firms in aviation, space, and communications fields, though related government agencies have shown interest in office space for key officials.* . . . Seeking to develop extended markets overseas, Control Data Corp., Minneapolis, has set up a subsidiary, Control Data AG, at Lucerne, Switzerland, and sales offices at Zurich, Switzerland and Bad Homburg, Germany. Other subsidiaries in Europe and Scandinavia are planned by the end of this year. C-D is a major U.S. manufacturer of large-scale digital computer equipment for research, engineering and control applications.

# AWARDS

## AIR FORCE

$19,985,000—**Boeing Co.,** Seattle, Wash., for follow-on research and development for the *Minuteman* weapon system (supplemental contract).

$17,325,000—**Martin Marietta Corp.,** Baltimore, Md., for continued work on the *Titan* missile program at Denver, Baltimore and Cape Canaveral (2 contracts).

$15,000,000—**American Telephone and Telegraph,** New York City, for operation, maintenance and support of the Distant Early Warning System.

$11,900,000—**Hercules Powder Co.,** Wilmington, Del., for continued research and development of *Minuteman* rocket at Baccus, Utah.

$8,000,000—**North American Aviation, Inc.,** Los Angeles, Calif., for research and development for the *Minuteman* guidance and control system (supplemental contract).

$7,300,000—**American Air Filter Co.,** Rock Island, Ill., for installation and environmental control equipment for launch facilities and launch control personnel at Ellsworth Air Force Base, S.D., *Minuteman* sites (3 supplemental contracts).

$5,500,000—**International Business Machines Corp.,** New York City, for maintenance and logistic support of SAGE computer systems.

$5,000,000—**General Dynamics Corp.,** New York City, for space parts and related material for *Atlas* missiles. Work to be done at San Diego, Calif.

$4,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for research and development for a space program.

$3,710,333—**General Electric Co.,** New York City, for development, manufacture, installation, test and evaluation of a modified precision trajectory measurement system for ballistic missile tests and evaluation. Work to be done in Syracuse, N.Y. and on the Atlantic Missile Range.

$2,550,000—**General Electric Co.,** New York City, for work on the *Titan II* program at Philadelphia, Pa. (supplemental contract).

$2,000,000—**General Dynamics Corp.,** New York City, for installation and checkout of *Atlas* missiles.

$2,500,000—**Lockheed Aircraft Co.,** for continued research and development of space systems.

$1,309,809—**Radio Corp. of America,** New York City, for production of a prototype optical surveillance subsystem. Work to be done at Burlington, Mass.

$1,308,721—**General Precision Inc.,** Tarrytown, N.J., for depot level maintenance and necessary factory repair of components of flight simulators and training devices. Work to be done at Binghamton, N.Y., and various installations.

$1,121,416—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on a classified program.

$295,345—**General Electric Co.,** Santa Barbara, Calif., for studies on information processing in command and control.

## ARMY

$7,211,000—**Western Electric Co.,** New York City, for production of missile guidance sections for the *Nike Hercules* missile.

$4,673,327—**Ets-Hokin and Galvan, Inc.,** San Francisco, Calif., for the construction of main structural portions of a test stand at the George C. Marshall Space Flight Center, Huntsville, Ala., for static firing the first stage of the *Saturn C-5 Apollo* moon rocket.

$2,700,000—**Ford Motor Co.'s Aeronutronic Div.,** Newport Beach, Calif., for continued development work on the *Shillelagh* missile system.

## NAVY

$3,100,000—**Sperry Gyroscope Co.,** Great Neck, N.Y., for 14 advanced design checkout consoles that will further assure combat readiness of *Polaris* submarine navigation systems.

$1,232,343—**Martin Marietta Corp.,** Orlando, Fla., for transmitter radios for the *Bullpup* weapons system.

$279,000—**Bulova Watch Co., Inc.,** New York City, for mechanical fuzes for the warhead of *Bullpup* missiles.

## INDUSTRY

$1,400,000—**General Dynamics-Electronics,** San Diego, Calif., from **International Telephone and Telegraph Federal Laboratories,** for electronics equipment to be used in a control system being created for SAC.

$1,000,000—**Electronic Specialty Co.,** Los Angeles, Calif., from **Lockheed Electronics Co.,** Plainfield, N.J., for PICO (micro-micro) miniature relays to be used in Lockheed's MADRAC system (Malfunction Detection and Recording).

$50,000—**Thompson Ramo Wooldridge, Inc., RW Div.,** Los Angeles, Calif., from the **Applied Physics Laboratory of Johns Hopkins University,** for research on a prototype "woven screen" computer memory plane for possible use in the Navy's navigational satellite system.

**North American Aviation, Inc.'s Los Angeles Div.,** from **Coordinating Research Council, Inc.,** for a fuel system test program as part of the supersonic transport (SST) research program (undisclosed amount).

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

U.S. Army Missile Command
Redstone Arsenal, Ala.
Attn: AMCPM-SEPM

Guidance section, guided missile, AN/DJW-8. Control surface assembly guided missile. Nonrecurring tooling, recurring tooling. Notice is given that available specs, plans or drawings relating to this procurement do not fully provide all necessary manufacturing and construction details. Request for proposal has been issued to Sperry Rand Corp., Sperry Utah Co. Div., 322 N. 21st Street West, Salt Lake City, Utah. Security clearance will be required of successful bidder or offeror.

---

General Support Div.
Directorate of Procurement & Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

The Army proposes to procure from Northrop Corp., Ventura Div., engineering services in connection with the Type III (RP-76) target missile system. All inquiries concerning subcontracting opportunities in connection with the procurement of these services should be addressed to Northrop Corp., Ventura Div., Van Nuys, Calif.

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National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

Provide two space environmental air conditioning control systems, no test chambers, one for Launch Complex 37A, one for Launch Complex 34, required for configuration of *Saturn* vehicle. Perform all necessary procurement modification and testing at contractor's plant, shipping to and installation at Cape Canaveral. Functional checkout of systems after installation. Each system comprises four major items. This is a reissue of IFB CC-37-2, synopsized 6-11-62, and contains additional revisions of specs. Job—IFB CC-21-3. Bid opening 9-21-62. Contact LO-P&C-P. Mr. E. E. Murchison, 305-783-8034 for additional info if required.

---

U.S. Army Engineer District Los Angeles
Corps of Engineers
751 Figueroa St.
Los Angeles, Calif.

Emergency rocket communication system at Vandenberg AFB, Calif. Job—IFB ENG-04-353-63-13. Bid opening 9-11-62. Approximate value $200,000. Specs and plans available at $10 per set. Make check or money order payable to Treasurer of the U.S. and forward to Attn: Plan Room, above address. Charges are not refundable.

---

U.S. Army Engineer District Jacksonville
575 Riverside Ave.
Jacksonville, Fla.

Construction of modifications to Complex 12 service tower (NASA), Cape Canaveral Missile Test Annex, Air Force Missile Test Center, Patrick AFB, Fla. Job—IFB ENG-NASA-08-123-63-7B. Bid opening 9-27-62. Payment in advance of $10 per set of drawings and specs is required before papers will be furnished. Payment will not be refunded. Approximate cost $250,000.

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Picatinny Arsenal
Picatinny, N. J.

Device dud recovery, mobile less vehicle, approximate weight 1700 lbs. Material steel and aluminum. Delivery one each within 60 calendar days from date of award. Balance, one each thereafter until completion. FOB contractor's plant. Bid forms available at all Ordnance Districts. Item A, 6 each or Item B, 3 each—IFB 63-28B-Bid opening 9-16-62.

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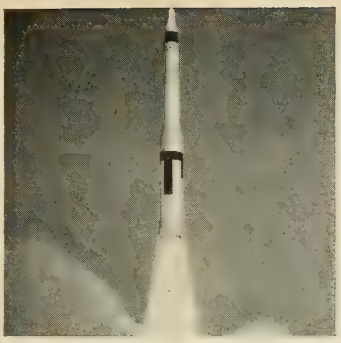
Defense Construction Supply Center
Defense Supply Agency
52 Starling St.
Columbus, Ohio

Repiar parts, various manufacturers' numbers, to support the *Pershing* weapons system. Deliveries to: Columbus, Ohio; Memphis General Depot, Memphis, Tenn.; Utah General Depot, Ogden, Utah. Requests for proposals have been issued to Martin Marietta Co., the prime manufacturer and other coded subcontractors—RFP-DSA—7-63-Neg. —430. RFP due date 9-14-62.

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Procurement Branch
Aberdeen Proving Ground, Md.

Furnish personnel, materials and equipment and facilities for the development of ballistic measurement equipment. The work and services to be performed will essentially consist of task assignments directed by the technical supervisor and will include, but not be limited to, electronic instruments, subassemblies of components, systems of equipment, special antennas and detection systems. The rate of effort outlined above is estimated at 10,000 man hours of which approximately 80% is manufacturing labor and 20% engineering due to the close liaison required between the technical supervisor and the contractor. Request for proposals will be limited to firms within a radius of 50 mi. of Aberdeen Proving Ground, Md. RFP available from the Philadelphia Ordnance—RFP due in the district office 9-27-62—RFP RD-APG 12-63.



Minuteman launch controls



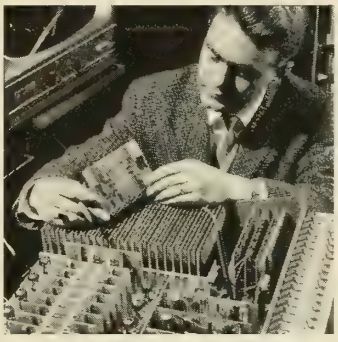
Electronic circuitry design



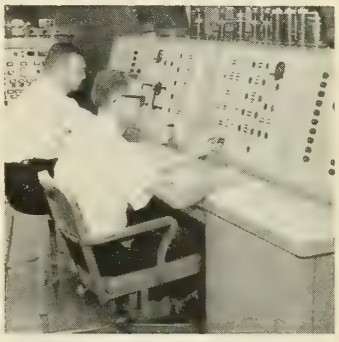
Solar power research



Electronic manufacturing



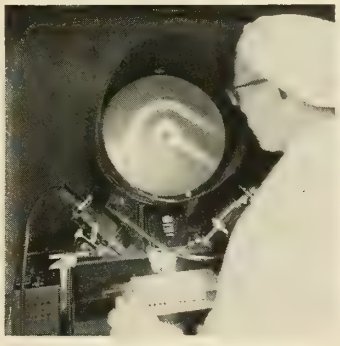
Computer technology advancement



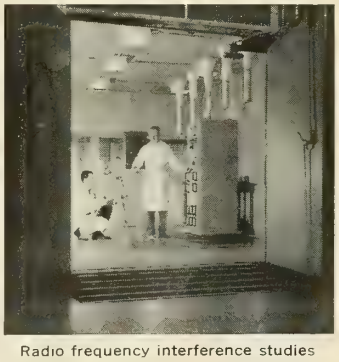
Console design and manufacture



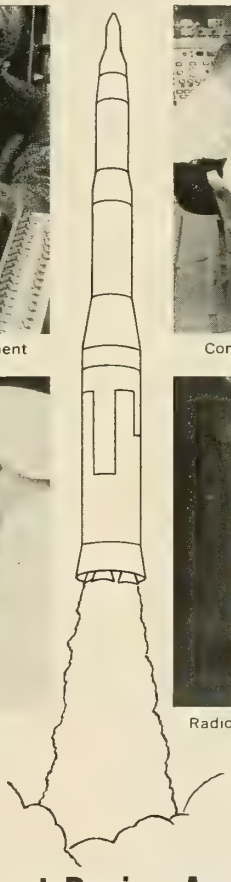
Satellite control research



Electronic circuit inspection



Radio frequency interference studies



# Electronics capabilities – at Boeing Aero-Space Division

More than 4,000 of Boeing's Aero-Space Division's personnel are engaged in electronics research, design, manufacturing and applications activities.

Twenty-one electronics organizations provide everything from advanced research to the components and total systems required by the Division's programs. General areas of activity include countermeasures, radar optical systems, infrared, communications, radio navigation, antenna development, electrical materials and radiation-effect studies.

Currently, Aero-Space Division is manufacturing the launch control system for Minuteman, flight electronics for the X-20 (Dyna-Soar) space glider, hydrofoil autopilot system interface equipment, security systems, an orbital tracker and airborne communications.

In electronics, as in all phases of systems management, emphasis on quality control and reliability engineering has contributed toward the Division's outstanding record of performance. It has also assured the design and development of superior products, manufactured and delivered on schedule.

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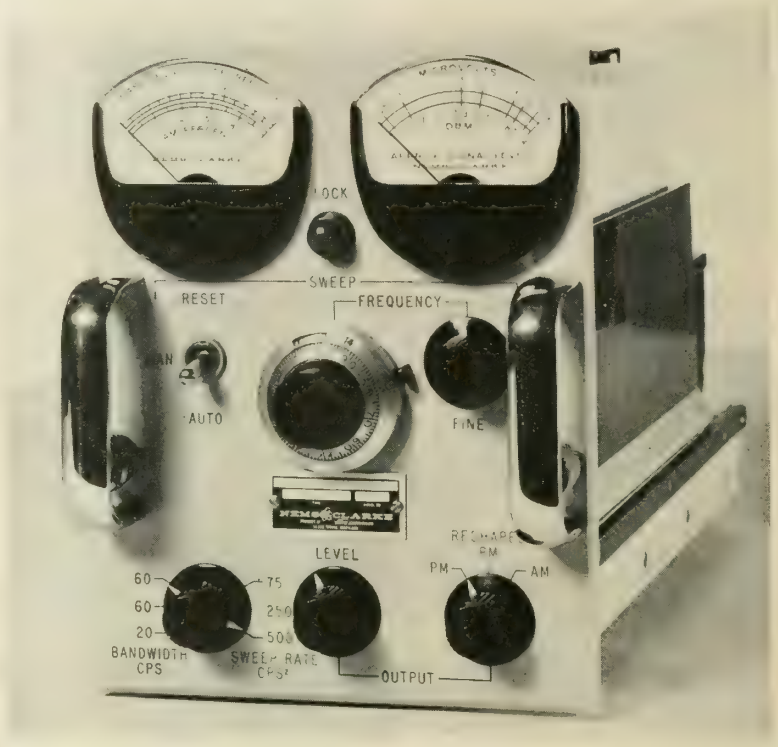
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## *New Product of the Week:*

## *PCM/PM Modules*

PCM/PM PLUG-IN type modules for searching, tracking and locking onto carrier signals (as low as −145 dbm and which will maintain lock at −150 dbm) from missiles and satellites, have been developed by Vitro Electronics.

The solid-state modules incorporate anti-sideband locking to assure accurate carrier tracking. AGC of the equipment has been maintained for signal strength lower than locking threshold. An ultra-linear phase detector is used to guarantee low distortion reception with a signal modulation as high as one radian. A pulse reshaping circuit is included.

Circle No. 225 on Subscriber Service Card

## Waveform Multiplexing

A method of multiplexing known as Orthomux has been developed by Bernard Electronics Co. Either discrete digital or proportional analog modulation may be used on different channels simultaneously and an automatic reference for all control signals can be transmitted. Greater rejection of extraneous noise and interference is possible, together with simplified automatic synchronization, precluding the possibility of frame slippage. Additional channels can be incorporated by adding extra modules.

Applicable to any multi-channel system including voice, teletypewriter, telemetry and digital data link, Orthomux uses correlation process to separate the carriers and to recover the information on each channel.

The manganese dioxide is available in two grades; GEM-250 and GEM-251, the alkali content of the former being less then 0.04% and of the latter of 0.013%. GEM-81 calcium carbonate and GEM-90 are of higher purity than is normally supplied to the pharmaceutical industry. Barium carbonate, GEM-110, white powder having a needle-like particle shape. Aluminum oxide is available in two particle size ranges; 0.03-0.07 micron and 0.3-0.7 micron.

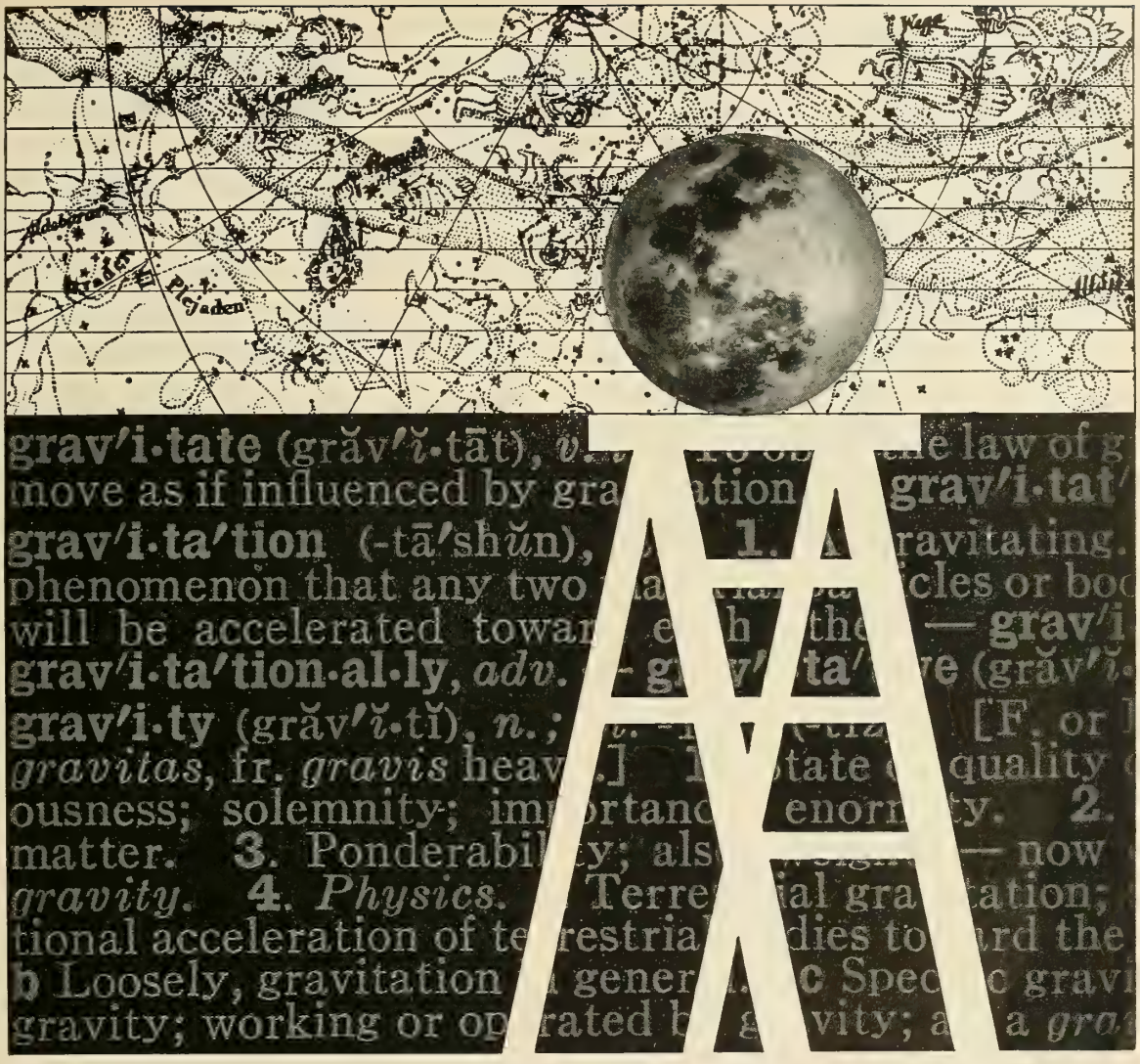
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A version of the Cyclonome® magnetic stepping or impulse motor, capable of delivering 350 gm.cm. of torque in discrete 18° steps, has been developed



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by Sigma Instruments, Inc. The motor is useful for process control and other instrumentation loads, magnetic tape, recording strip charts, rotary indexing mechanisms and switching devices.

Model 9AG000 Cyclonome has an operating value of 300 ampere-turns, saturation value of 800 ampere-turns, and holding torque with no current in the winding of 500 gm.cm.

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## Linear-Phase Shifter

A wide-band linear-phase shifter using a variable ultrasonic delay has been developed by Anderson Laboratories. The unit provides an extremely linear phase vs. frequency shift over bandwidths of 10 Mc/S or more. Frequency ranges from 10-60 Mc. are available. Delay changes may be specified within the range of 2-200 usec. Resolution is infinite and phase adjustment to 1° is possible.

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## High-Temperature Crucibles

Space Age Materials Corp. is marketing high-temperature crucibles known as PYRO-CRU which can be used at temperatures of 3400°C in inert atmospheres.

Prolytic graphite has a density of 2.22 and is impervious to helium. These crucibles can be used for melting, sintering or compacting refractory metals —such as chromium, titanium, vanadium and silicon—as well as refractory compounds and ceramics.

Circle No. 229 on Subscriber Service Card

# new literature

MACHINED TERMINALS—A four-page, two-color brochure on precision-machined standard terminals for the military and commercial OEM markets has been released by Concord Electronics Corp. Included are the many finishes available for these terminals.

Circle No. 200 on Subscriber Service Card

DEVAR PREAMPLIFIER — DeVar-Kinetics Division of Consolidated Electrodyne Corp. has issued Bulletin No. IM-511 describing the DeVar preamplifier. Features of the preamplifier are: unique inductive calibration which permits continuous range adjustment; high common mode and noise rejection; internal reference junction compensation for thermocouples; and simultaneous a-c and d-c output signals. The two-page bulletin gives performance specifications and curves, describes the principle of operation, and provides a circuit diagram.

Circle No. 201 on Subscriber Service Card

LOW-FREQUENCY OSCILLATORS —A number of low-frequency crystal-controlled oscillators, for applications as a high-stability frequency source or high-accuracy timer reference, are described in a new two-page catalog sheet from Electronics Div., Bulova Watch Co., Inc. The sheet is written for application, design or circuit engineers. The oscillators described range from 1 cps to 20 kc, and their stabilities range from 2 pp $10^6$ to 1 pp $10^8$ for an hour's operation. There are descriptions of other characteristics—including wiring instructions when binary dividers are used, outside dimensions, applicable Mil Specs, etc.

Circle No. 202 on Subscriber Service Card

BRIDGE PERFORMANCE GRAPHS —"Design Ideas," Electro Scientific Industries' quarterly technical bulletin, presents a detailed discussion of a new graphic method of specifying bridge outputs and detector sensitivities so that their combined performance can be readily analyzed for any given measurement. Separate plots of bridge output and detector sensitivity are made for the whole range of impedance values within the bridge capabilities.

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MINIATURIZED SIGNAL TRACER — The "Stethotracer," a multipurpose self-contained signal tracer the size of a fountain pen, for defective circuits troubleshooting and electronic components in all types of radio, audio and electronic equipment, is the subject of a catalog page issued by Don Bosco Electronics, Inc., a subsidiary of Howell Electric Motors. The instrument is fully described, as are accessories that adapt it for use, among other purposes, as an oscilloscope or voltmeter preamplifier for detecting low-level signals in the microwatt region.

Circle No. 204 on Subscriber Service Card

OCEANOGRAPHIC EQUIPMENT—Hydro-Space Technology, Inc., offers an eight-page brochure plus product data sheets—complete with diagrams, photographs, and specifications—entitled "Cartridge-Actuated Devices and Oceanographic Equipment." Ballistic gas generators, explosive valves and bolts, linear thrusters, pneumatic systems, drogue guns and buoyancy devices are dealt with separately on product data sheets that define the devices and explain their operation and reliability.

Circle No. 205 on Subscriber Service Card

POWER SILICON TRANSISTORS—A six-page bulletin covering applications and specifications of its new 2N2034 series of miniaturized high-power silicon transistors has been announced by Silicon Transistor Corp. The illustrated, two-color bulletin also includes specifications and technical data on the 2N2034 as well as on the 2N2035 in the TO-8 package, and on the 2N2036 in the TO-37 package. The latter devices, which are in the series, feature higher dissipation.

Circle No. 206 on Subscriber Service Card

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**UNITED STATES GOVERNMENT:**
Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

**INDUSTRIAL SECTION:**
Detailed listings of major missile/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

**COMPANY REPRESENTATIVES SECTION:**
Listing company representatives stationed in Washington and in most strategic missile/space areas.

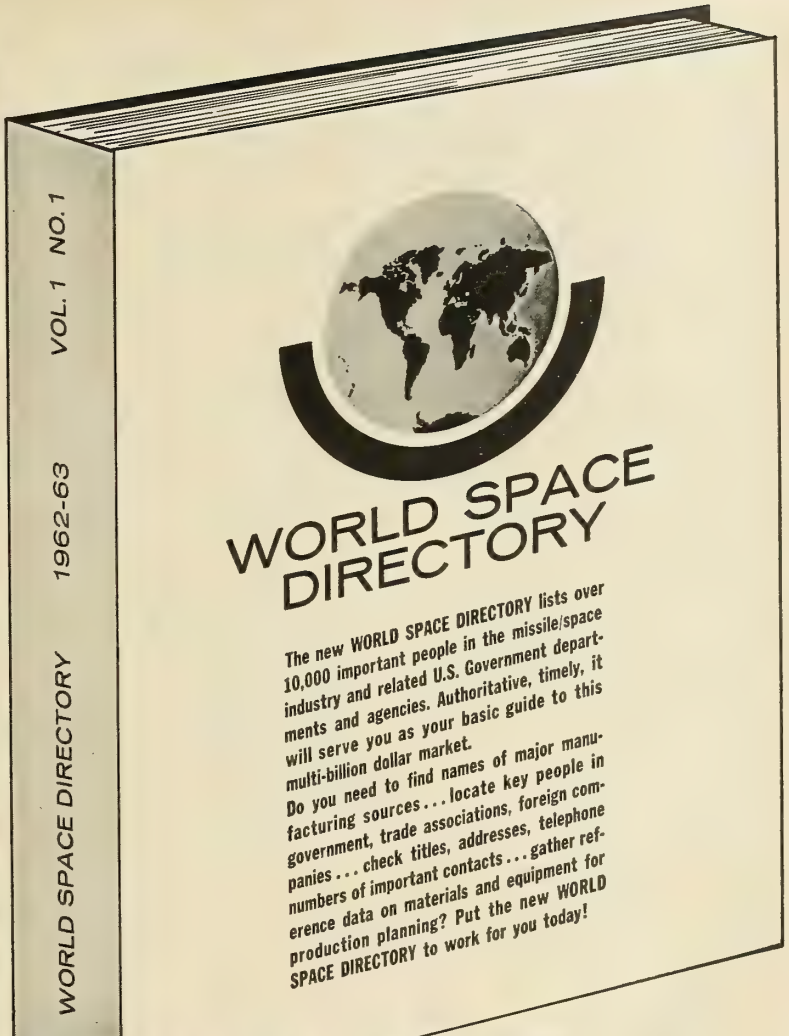
**INTERNATIONAL SECTION:**
Covers all countries with missile/space activities, plus all NATO member nations.

**PERSONNEL INDEX:**
A cross-referenced index of over 10,000 key personnel in industry and government.

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North American Aviation


## –names in the news–

**Robert L. Johnson:** Appointed vice president-director of Douglas Aircraft Co.'s Space Systems Center, Huntington Beach, Calif. Also announced were the appointments of **John L. Sigrist,** vice president-operations; **Ted D. Smith,** director-*Saturn* program; and **Ted Gordon,** chief engineer-*Saturn* program.

**John L. Lombardo:** Named general manager of General Dynamics/Electronics, San Diego, Calif.

**William J. Fox:** Elected executive vice president of Dorr-Oliver, Inc., Stamford, Conn. **C. Richard Soderberg, Jr.** elected a vice president of the corporation.

**Neil E. Rogen:** Named president of the newly established Rate Engineering Corp., Waltham, Mass. **Ralph S. Bruce** named vice president, marketing; and **Sylvester W. Bies,** vice president, engineering.

**Paul H. Bottoms:** Appointed vice president-new product development of Swedlow, Inc., Los Angeles, Calif.

**David H. Spiller:** Elected secretary of The Electric Autolite Co., Toledo, Ohio.

**D. H. Wilke:** Formerly technical director, named general manager of the Micronics Div., Industrial Group, Elgin National Watch Co., Chatworth, Calif.

**Nelson C. Harnois:** Appointed executive vice president of TEMEC, Inc., Van Nuys, Calif.

**Earl R. Hinz:** Appointed director of applications engineering for Northrop Space Laboratories, Hawthorne, Calif.

**Ward C. Humphreys:** Elected vice president of Kaiser Industries Corp., Washington, D. C.

**John H. Wickham, Jr.:** Named head of the Photogrammetric Systems Div. of Keuffel & Esser Co., Hoboken, N. J.

**J. J. Ghiglia:** Appointed vice president of Temptron, Inc., Reseda, Calif.

**Dr. William H. Watson:** Former head of the physics department at the University of Toronto, joined the Research and Engineering Laboratories of Lockheed Missiles and Space Co. as a consulting scientist.

**Kenneth B. Gay:** Appointed director of material of North American Aviation, Inc., El Segundo, Calif.

**Col. Richard M. Baker (USMC ret.):** Joined E. W. Bliss Co., Canton, Ohio, as technical liaison representative.

**Edwin B. Gilroy:** Appointed assistant to the president and director of personnel for Voi-Shan Industries, Inc., Pasadena, Calif.

**Morris Mokren:** Named manager of administration at Otis Elevator Co.'s Defense and Industrial Div., Santa Ana, Calif.

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*Agency—S. G. Stackig, Inc.*


# when and where

### SEPTEMBER

**Fourth National Conference on Applied Meteorology, American Meteorological Society,** Hampton, Va., Sept. 10-14.

**Tenth Annual Engineering Management Conference,** IRE, Hotel Roosevelt, New Orleans, Sept. 13-14.

**Hydrofoil & Air Cushion Vehicles National Meeting, sponsored by the IAS and Navy Bureau of Ships,** Shoreham Hotel, Washington, D. C., Sept. 16-18.

**Air Force Association's Sixteenth National Convention and Aerospace Panorama,** Nellis AFB Gunnery Range, Las Vegas, Nev., Sept. 18-23.

**Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences,** Hotel Commodore, New York City, Sept. 19-20.

**Eleventh Annual Industrial Electronics Symposium, sponsored by IRE, American Institute of Electrical Engineers and Instrument Society of America,** Sheraton Hotel, Chicago, Sept. 19-20.

**IRE Conference on Communications,** Roosevelt Hotel, Cedar Rapids, Iowa, Sept. 21-22.

**National Power Conference, (ASMW-AIEE),** Lord Baltimore Hotel, Baltimore, Md., Sept. 24-26.

**Space Power Systems Conference, ARS,** Miramar Hotel, Santa Monica, Calif., Sept. 25-28.

**Symposium on the Physics of Failure in Electronics, sponsored by Rome Air Force Development Center, USAF Systems Command and Armor Research Foundation,** Illinois Institute of Technology, Chicago, Sept. 26-27.

**Symposium on Dynamic Behavior of Materials, sponsored by the University of New Mexico and Rocky Mt. District of American Society for Testing Materials,** Statler Hilton Hotel, Los Angeles, Sept. 30-Oct. 5.

### OCTOBER

**National Communications Symposium. Institute of Radio Engineers,** Hotel Utica, Utica, N. Y., Oct. 1-3.

**Third Symposium on Advanced Propulsion Concepts, sponsored by General Electric Co. and AFOSR,** Sheraton Gibson Hotel, Cincinnati, Ohio, Oct. 2-4.

**National Symposium on Space Electronics and Telemetry, IRE,** Fountainbleau Hotel, Miami Beach, Fla., Oct. 2-4.

**10th Annual Human Engineering Institute, sponsored by Dunlop & Associates,** Stamford, Conn., Oct. 2-5.

**18th Annual National Electronics Conference and Exhibition, sponsored by AIE, IRE, Illinois Institute of Technology, Northwestern University and University of Illinois,** McCormick Place, Chicago, Ill., Oct. 8-10.


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# Power and the Pentagon

WE WOULD BE against the increasing centralization of military functions in the hands of Secretary of Defense Robert McNamara and his DOD staff even if it were accompanied by a show of competence. It is not.

On the contrary, events of recent weeks have raised the question of whether DOD management is sufficiently competent to run an unruly girls' boarding school. The implications for the missile/space industry are ominous.

We are not in favor of unification of the three services and we are not in favor of the general staff concept. There is need for Pentagon standardization in such areas as patent policies, procurement and contracts, purchase of common use items and personnel programs. Secretary McNamara and his team got off to a good start in a number of these areas. We have, in fact, applauded his efforts to bring common sense into Pentagon procurement practices (M/R, Nov. 20, 1961, p. 50).

But he now seems to have confused standardization with unification. The pendulum has swung too far and it must be stopped. There is considerable benefit to the nation from properly-controlled competition between the services. Many of our most successful weapon systems are a result of the drive created by such competition.

Could a *Polaris* system have come to fruition under today's Pentagon management? It is more likely that the Navy, in the interest of economy, still would be struggling to fit a *Jupiter* missile on a submarine.

The individual services must be permitted more freedom than they now possess to develop the weapons they need. Individual service personnel are being reduced to the status of bus drivers and streetcar conductors—told to operate the vehicle assigned to them by management or find a job elsewhere.

The Pentagon civilian management group is trying to decide what the military requirements of each service are, what specific weapons are required to fill those requirements, what carefully-delineated subsystems and components are needed for those weapons, what the dollar cost will be to the final penny, and what contractors should be blessed with the awards.

Perhaps it's a great way to build automobiles but it won't work with weapon systems.

It is an arrogation of functions beyond the competence of the DOD staff. It inevitably will result in a deterioration of U.S. military strength. It also inevitably must result in a deterioration of performance in such traditional DOD functions as allocation of missions between the services, provision of the necessary financial management, overseeing of service programs to prevent undesirable duplication (not all duplication is undesirable), and ascertaining that no important research and development areas are neglected by the individual services.

Secretary McNamara and his staff cannot do well all the things DOD must do well, together with all the things the three services must do well. Yet that is what they are trying to do. The result will be that nothing is done well.

Let's take a look at recent DOD performance in some critical management areas.

Politics? Item: DOD management consistently has used defense news releases for maximum political benefit. Item: Many weeks ago, we predicted award of a major missile contract to a firm in a politically sensitive state. Dozens of firms then were in the competition. Our entry now is one of two semi-finalists and still looks good. Item: A top official of a major aerospace firm is about to be sacked because he became entangled in the politics of a recent missile award. Politics in defense management? Most assuredly.

Depressed areas? Sen. Engle (D-Calif.) said he was advised in an Aug. 15 letter from Ronald M. Linton, director of DOD economic utilization policy, that there are no DOD plans to divert defense contracts to depressed areas. But the same Mr. Linton outlined a DOD program to the Senate small business committee which calls attention to an interesting clause: certain defense contracts require the prime contractor to agree either to perform 50% of the contract value in a labor surplus area or subcontract 50% of the value in labor surplus areas. If the contractor fails to agree, the next low bidder who is within 20% of the lowest bid will be given an opportunity to meet the price and set-aside provisions. This can be death to competent program management and should be drawing the strongest industry protests. Depressed area contracting in defense management? Most assuredly.

IS DOD MAKING the fullest use of the military knowledge and capabilities of the three services? Ask the Air Force, Army or Navy—off the record, of course. Is DOD making the fullest use of private industry in R&D and systems engineering? The trend is in the opposite direction. Is DOD making provision for close liaison between industry and military? Just the contrary. Look at the disgraceful blue-penciling by DOD of AF's planned industry briefing at Colorado Springs.

"I consider it both inappropriate and unwise to expose industrial, congressional and other non-Defense Department personnel to forward thinking and plans not yet submitted to Mr. McNamara or me," Deputy Defense Secretary Roswell Gilpatric informed Air Force Secretary Eugene Zuckert in a curt memo concerning the briefing. It was a direct slap at traditional Air Force-industry relationships.

Congressional and industry leaders should make every effort to halt the DOD arrogation of service functions. A good place to start would be in Mr. Gilpatric's own Defense Industry Advisory Committee.

There is no question that final power and authority over the military should be in civilian hands. But that power now is being misused—and the misuse should be halted.

**William J. Coughlin**

The great paradox of our time, perhaps of all time, is that peace depends on our capacity to fight a war. Thus the person who contributes to our military strength, contributes to the cause of world peace.

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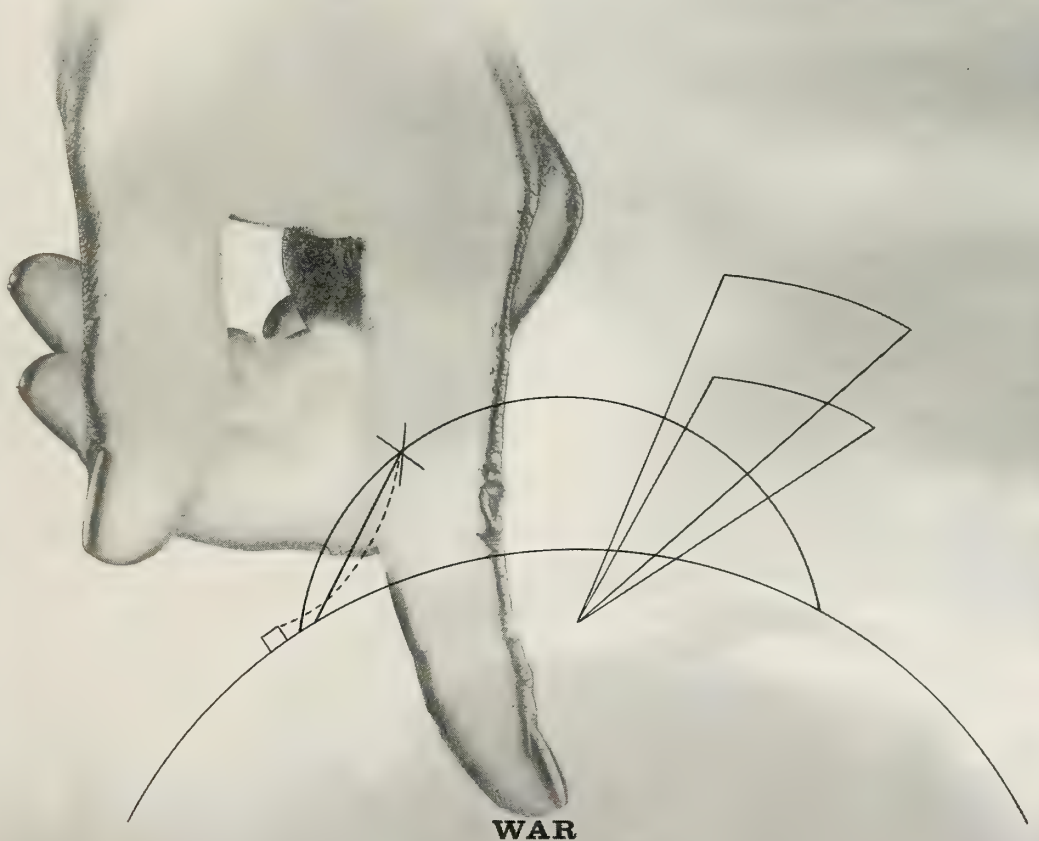
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***How would the commander command?***

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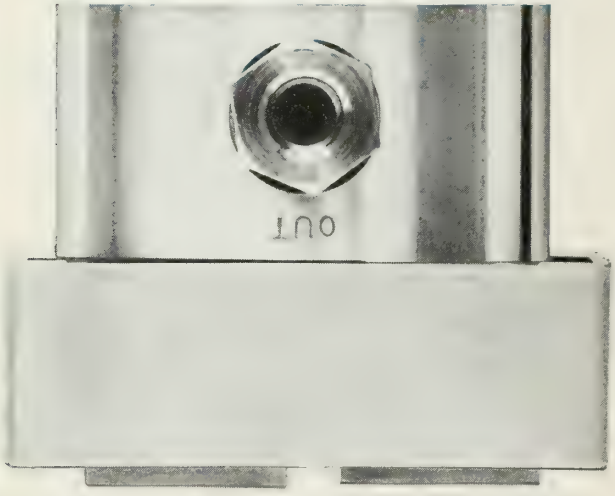
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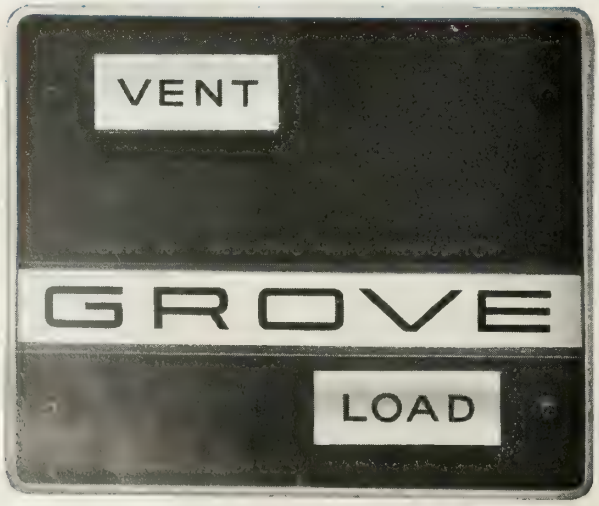
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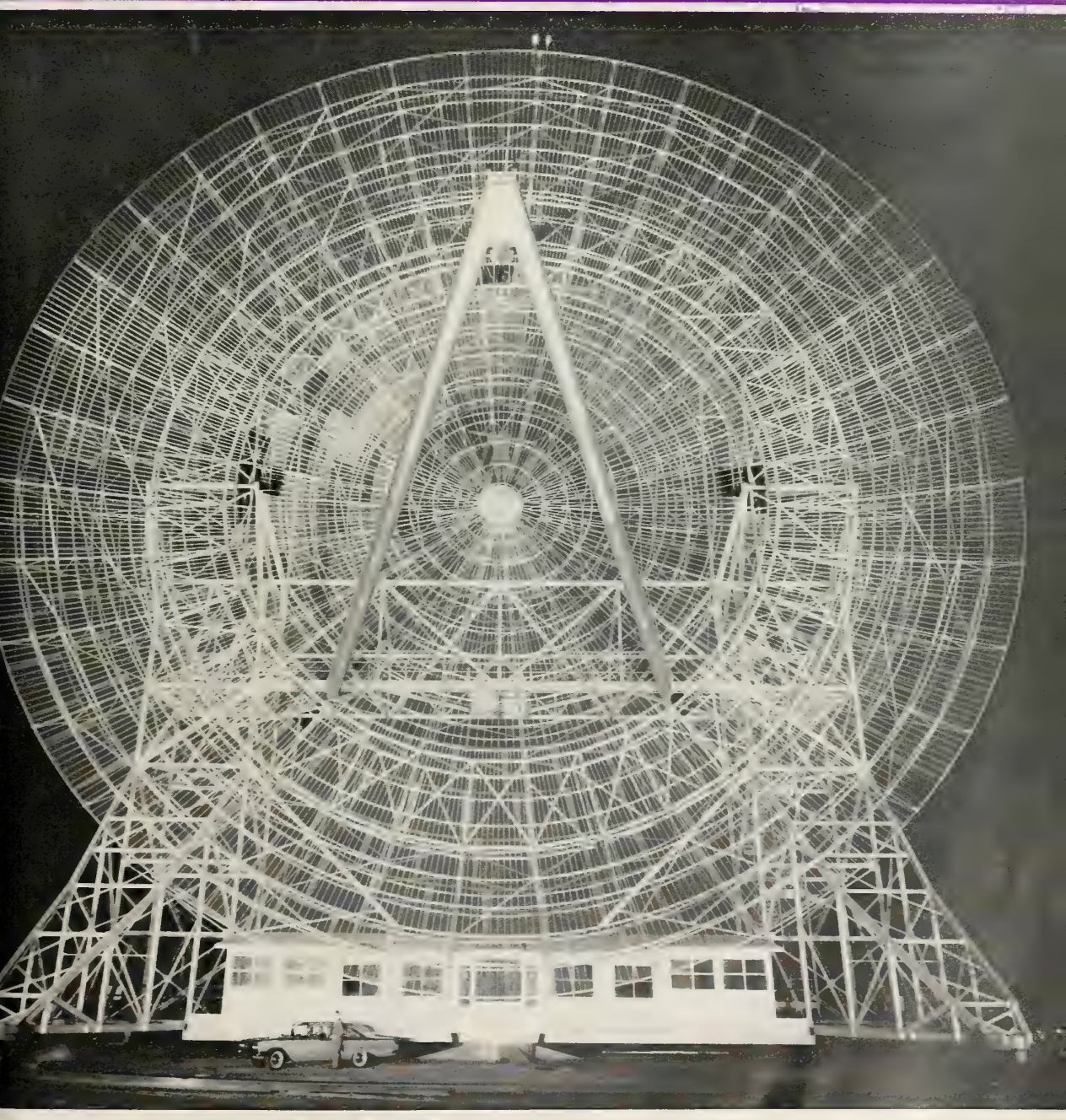

# New rapid load and vent loader for aerospace



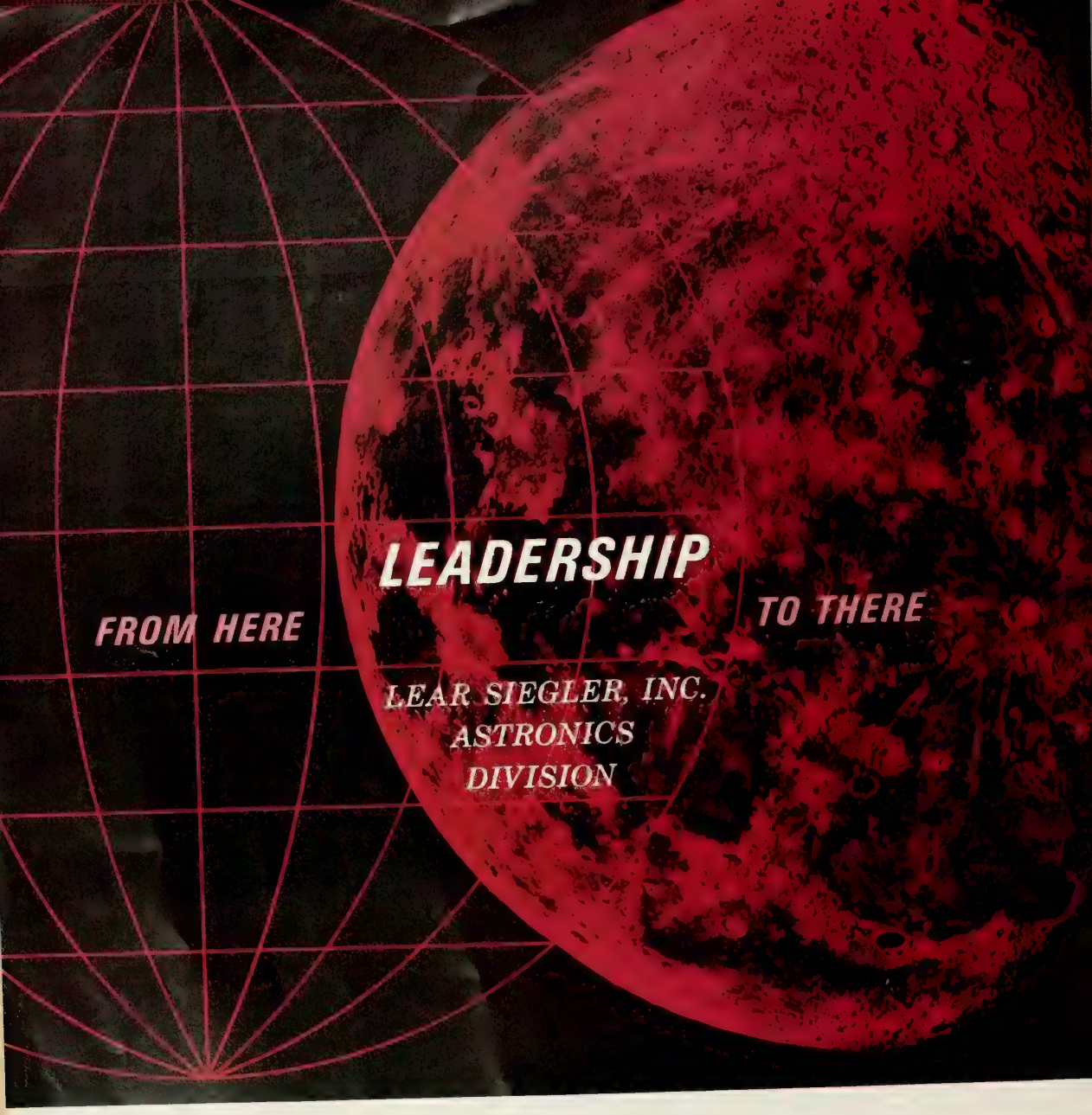

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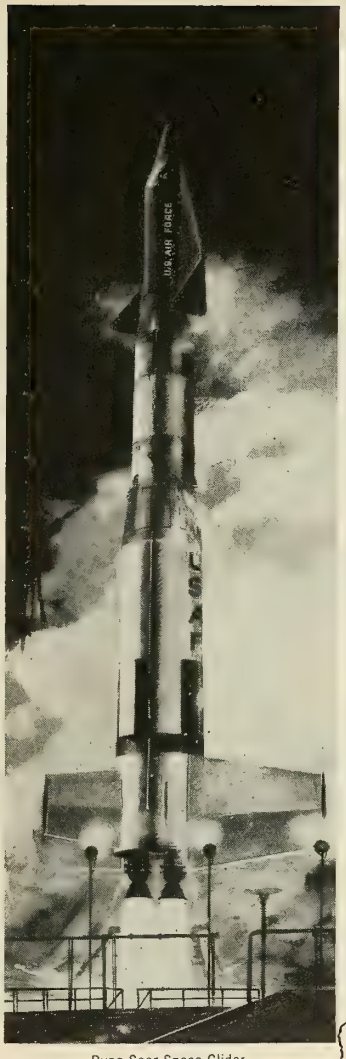
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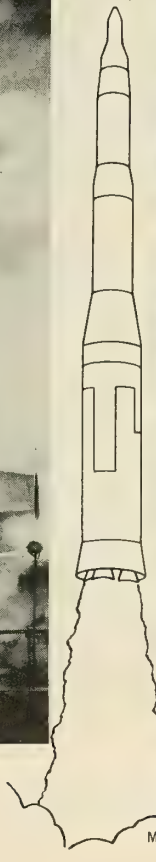
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Saturn Launch Vehicle




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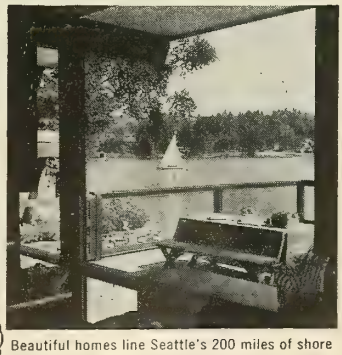
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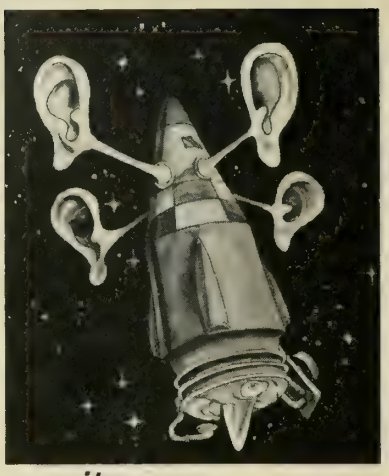
*preamplifiers*



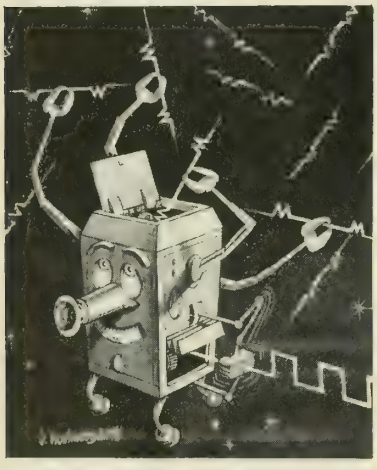
*receivers*



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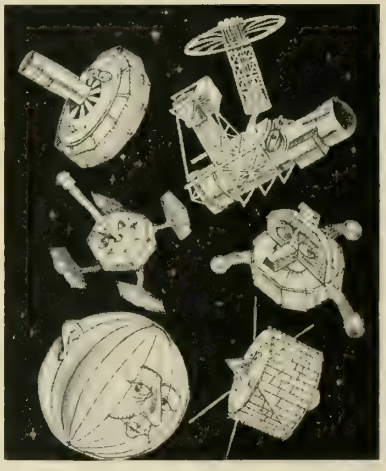
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# missiles and rockets

Volume 11, Number 12 September 17, 1962

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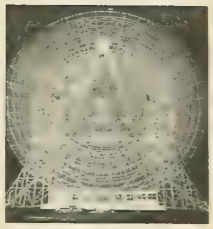
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## THE COVER

*This 150-ft. diameter radio telescope at Stanford University will begin probing space later this year. M/R's special report on space electronics begins on p. 22.*

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*An up-to-date analysis of space electronics prepared by the M/R staff under direction of Senior Electronics Editor Charles D. LaFond.*

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**STEERING GEAR FOR MERCURY ASTRONAUTS**—Jet Reaction Controls, developed by Bell, control the roll, pitch and yaw of the Mercury capsule in space.

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# The Missile/Space Week

## New Satellite Program

NASA has started a crash program to develop a new satellite for measurement of the radiation belt created by the high-altitude U.S. nuclear explosion last July 9.

Space agency officials said the satellite will be launched in October using the reliable *Delta* booster. A second backup spacecraft also is being built by NASA. The program is under direction of the Goddard Space Flight Center.

Prime objectives are to measure the density and longevity of the belt which extends from 200 to 700 miles above the earth.

Disclosure of the new program indicates that government agencies are not sure of their conclusion that the belt is no hazard to manned spacecraft.

A NASA-AEC-DOD scientific report recently said the belt would not affect Project *Mercury's MA-8* flight scheduled for late September or early October.

The new satellites are to be launched from Cape Canaveral in a $9-million program as part of the *Explorer* series. They will be similar to *Explorer XII,* launched Aug. 15, 1961 to provide information on the Van Allen radiation belts.

The *Delta* booster will be called upon to perform a dog-leg maneuver for orbital injection, which will give the 100-lb. satellite a 19° inclination to the equator in order to transverse the radiation belt. Apogee will be 9000 n. mi.; perigee, 150 n. mi.; period, five hrs.

Scientific instrumentation, to be provided by Bell Telephone Laboratories, University of New Hampshire and University of California, will include two electron-flux experiments, a magnetometer, an optical aspect sensor to determine orientation to the Sun, an ion-electron experiment, and an electron pitch angle detector.

Instrumentation will be redundant to provide an expected 60-day lifetime. Solar cells of the satellite will carry a glass coating to lessen radiation damage.

John W. Townsend, Jr., assistant director of Goddard, is project manager. Dr. Wilmot Hess is scientific advisor.

## Shots of the Week

A terse announcement Sept. 6 revealed that the Navy's new 2500-mile Lockheed *Polaris A-3* failed to achieve its full flight distance after launch from a land pad at Cape Canaveral. Observers said the malfunction appeared to be in the missile's second stage. They noted a bright flash similar to an explosion after first stage burnout and before the second stage continued on.

- A Martin *Titan II* was successfully launched from Cape Canaveral Sept. 12 on a 5000-mile flight down the Atlantic Missile Range.

## With Mariner Toward Venus

NASA's *Mariner II* spacecraft at 12 noon EDT Sept. 11 was 2,548,905 miles from the Earth and travelling at 6512 mph. The 447-lb. spacecraft was launched from Cape Canaveral Aug. 27.

On Sept. 4, a planned midcourse correction was carried out successfully and the flight path of the spacecraft was altered to bring *Mariner II* within 9000 miles of Venus Dec. 14.

## Kennedy Backs Space Effort

President Kennedy has called on the nation to support any effort necessary to make the U.S. supreme in space.

The President, in a Sept. 12 speech in Houston, declared the U.S. must overtake Russia to insure that space is not used for military purposes.

The speech followed a visit to NASA's Manned Spacecraft Center located in the same city. On a two-day tour, the chief executive also visited the Marshall Space Flight Center, Cape Canaveral and McDonnell Aircraft Corp.'s Project *Gemini* operations in St. Louis.

## Sputnik IV Breaks Up

A 14-lb. chunk of steel tentatively identified as part of Russia's *Sputnik IV,* launched May 15, 1960 has been subjected to radiological tests at Los Alamos Scientific Laboratory.

The saucer-shaped steel plate weighed 20 lbs. when it landed Sept. 15, white hot, in Manitowoc, Wis.

While its radiation level was so low the piece could be handled with complete safety, it was still higher than that registered by any previous object recovered from space. One reason for this is the fact that the sample was analyzed only three or four days after it was found. Another reason is that if it is part of *Sputnik IV,* it has been in space for 2½ years.

Principal evidence for believing it is part of *Sputnik IV* is that U.S. astronomers had been tracking the Russian satellite several days, anticipated its probable breakup in the atmosphere and actually witnessed the event by telescope. Recovery spot in Wisconsin closely corresponded with the predicted landing.

## Lockheed Names Gribbon

Daniel J. Gribbon succeeds David F. Sanders as president of Lockheed Electronics Co., Plainfield, N.J. Gribbon, former assistant general manager of Lockheed Missile & Space Co.'s Space Systems Div., was also elected to the board of directors of Lockheed Aircraft Corp. He is a vice president of the corporation.

## Apollo Tests at White Sands

NASA will spend $15 to $18 million for facilities to test the *Apollo* spacecraft's propulsion and abort systems at White Sands Missile Range, New Mexico.

Facilities for flight tests of the abort system and the lunar excursion module will be ready in January, 1963. Static test sites for the firing of propulsion systems will be operational in mid-1963.

White Sands was selected for the abort tests because of a requirement for a highly instrumented land impact area, NASA officials said. The propulsion development site was chosen from 15 potential areas because of toxic fuel safety requirements necessitating a remote area.

The propulsion complex will include three test-firing stands, a control center blockhouse, storage and utility buildings and an administrative services center. The 88-sq.-mi. site will be large enough to conduct hovering and landing development tests of the lunar excursion module.

The *Apollo* service module propulsion system, under contract to Aerojet-General, also will be tested. Construction work at the propulsion site will be directed by North American Aviation, Inc.

Location of the complex will be on the western edge of the range about 20 miles from Las Cruces, N.M.

In the White Sands Missile Range flight test area proper, a program of off-the-pad and in-flight tests will be conducted in the development of the *Apollo* spacecraft escape systems. Existing launch facilities at the southern end of the range will be modified for the tests.

The flight tests—utilizing the

*Little Joe II* booster—will duplicate launch and initial flight conditions which may be encountered on actual *Apollo* missions.

*Little Joe II* will be a fin-stabilized, solid-fuel launch vehicle similar in concept and about twice the size of the original *Little Joe* used for similar tests of the *Mercury* spacecraft.

The *Little Joe II* design calls for a cylindrical body 154-in. in diameter to house its propulsion system. The launch vehicle itself will be about 30-ft. from base to tip. With the payload—which at times will include the command, service and lunar excursion modules, as well as the escape tower—the test vehicle will measure 85 ft.

A cluster arrangement of as many as seven Aerojet Algol and Thiokol Recruit rocket motors will provide the power. The combination and number of motors used will depend on the payload and requirements of each test.

A new launch pad is being designed especially for the program. It will be a steel structure mounted on a concrete foundation and will have a remotely adjustable launching angle. The flight vehicles will be launched northward over the 100-mile-long range. A 40-mile extension is available if needed.

## Nuclear Tests To Continue

In a surprise announcement last week, the Defense Department and the Atomic Energy Commission revealed that the U.S. will conduct a "few" atmospheric nuclear tests beginning late this month. The series will include three high-altitude, rocket-launched tests.

Reconstruction of the *Thor* launch facilities at Johnston Island has been under way since a July 25 launch failure caused extensive fire and explosion damage.

The high-altitude tests are to be conducted at approximately 20, 50 and 80 mi. altitudes to provide an experimental profile of radar blackout and missile warhead neutralizing effects. All three explosions are expected to be of less than one megaton yield.

With the extension of the high-altitude series, DOD-AEC officials have won White House approval for desirable, high priority atmospheric tests which they were not able to accomplish at Christmas Island under the President's tight two-to-three-month original deadline. In addition, Defense officials feel that valuable weapons design information obtained from the early tests should be explored further.

Though the number of atmospheric tests was not specified, officials conceded that the word "few" should be taken quite literatlly.

Between April 28, when the atmospheric test series began, and July 12, when the government announced conclusion of the Christmas Island phase of the nuclear testing, the U.S. had conducted some 25 tests.

Only one of the nuclear devices in the high-altitude series was successfully detonated—on July 9. This device, estimated at about two megatons and detonated at about 200 miles, created a totally unexpected, highly persistent inward extension of the Van Allen radiation belt. A shot planned at 500 miles reportedly was cancelled to preclude further disturbances of the radiation belt.

## Construction at the Cape

The Corps of Engineers has awarded a contract to Consteel-Ets-Hokin & Galvan, Cocoa Beach, Fla., to modify *Titan* Launch Complex 19 for *Gemini*.

The $1,269,117 contract calls for construction of new propellant holding areas for the *Titan II*, a new white room, modification of the umbilical tower and construction of decontamination and ready rooms.

Completion date has been set for Feb. 1, 1963.

The Corps also has called for bids on two more Cape Canaveral construction projects.

Bids will be opened Oct. 10 for construction of a two-story missile research laboratory to be used by the Air Force. Estimated cost runs to $400,000.

The second project calls for bids to be opened Oct. 4 for construction of two government-furnished prefab steel buildings to serve as warehouses at the Cape. Estimated cost of the work has been set at $100,000.

## SINS Contract Awarded

Autonetics Div. of North American Aviation will build 39 improved Ship's Inertial Navigation Systems (SINS) for the Navy's *Lafayette*-class fleet ballistic missile submarines.

Under a $41-million contract, Autonetics will produce the improved SINS—designated Mark II Mod 2—for 10 *Polaris* submarines as well as nine spares. The company has furnished navigational systems for 24 of the 29 missile-firing submarines.

The Mark II Mod 2 system is expected to improve considerably the overall performance reliability and maintainability of SINS. Major improvements include: an improved inertial system, a higher-capacity digital computer and a redesigned binnacle unit to improve platform dimensional stability and environmental control.

## Michoud Construction

NASA has selected the firm of Mason Rust to manage construction of facilities for the *Saturn*-manufacturing Michoud Operations. The company will award, supervise, monitor, and coordinate construction of facilities contracts at the New Orleans installation. Plant modifications directly related to the *Saturn* boosters will remain the full responsibility of Michoud's prime vehicle contractors —Boeing and Chrysler.

## Simple Satellite Developed

An inexpensive satellite that can carry three or four experiments in its small, tetrahedral design has been developed by Space Technology Laboratories.

The four-sided, pyramid-shaped vehicle weighs one pound, measures 6 in. on a side and is priced as low as $20,000. STL says the small probe makes it cheaper to test materials in space than on Earth.

The Air Force is buying the gold-plated tetrahedral, designed to go aloft aboard other vehicles.

## NASA Studies Space Station

Top level NASA management held a lengthy meeting last week to discuss a manned space station program.

Informed sources reported the Sept. 12 meeting was held to brief top officials on the program and to discuss possible fiscal '64 funding.

## Tiros VI to Track Storms

NASA will attempt to launch its sixth *Tiros* weather satellite this this week. The launch is scheduled for Sept. 18.

*Tiros VI* is designed to provide meteorological data during the tropical storm season.

Originally scheduled for November, the launch date was moved up when the *Tiros V* satellite now in orbit malfunctioned. A random electrical failure cut off the spacecraft's medium-angle Tegea lens.

Because of the earlier launch date, *Tiros VI* will not be equipped to take infrared pictures.

## Bainbridge Launch Set

The Navy's first nuclear-powered, guided missile frigate, the *Bainbridge* (DLGN-25), will be launched Oct. 6 at Bethlehem Steel Co.'s Quincy, Mass., shipyard.

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## INTEGRATED CIRCUIT APPLICATIONS

**SCIENTISTS AND ENGINEERS:** Today Motorola is pacing a scientific revolution in electronics with a disciplined approach to integrated circuit applications. Under the personal leadership of Dr. Daniel E. Noble, the men of the Military Electronics Division are synthesizing the process technology and device design capabilities of Motorola's Semiconductor Products and Solid State Systems Divisions with military and space requirements. This coordinated effort, unique in the electronics industry, is yielding a new breed of reliable integrated circuit devices resulting from Motorola's broad range of jointly funded contracts with each of the three services, JPL/NASA and other government agencies. To implement programs such as these, marrying the frontier processing techniques of diffusion, epitaxial growth, electronic ceramics and thin films to practical electronic hardware applications, we can offer immediate opportunities to both systems and equipment design engineers experienced in the following areas.

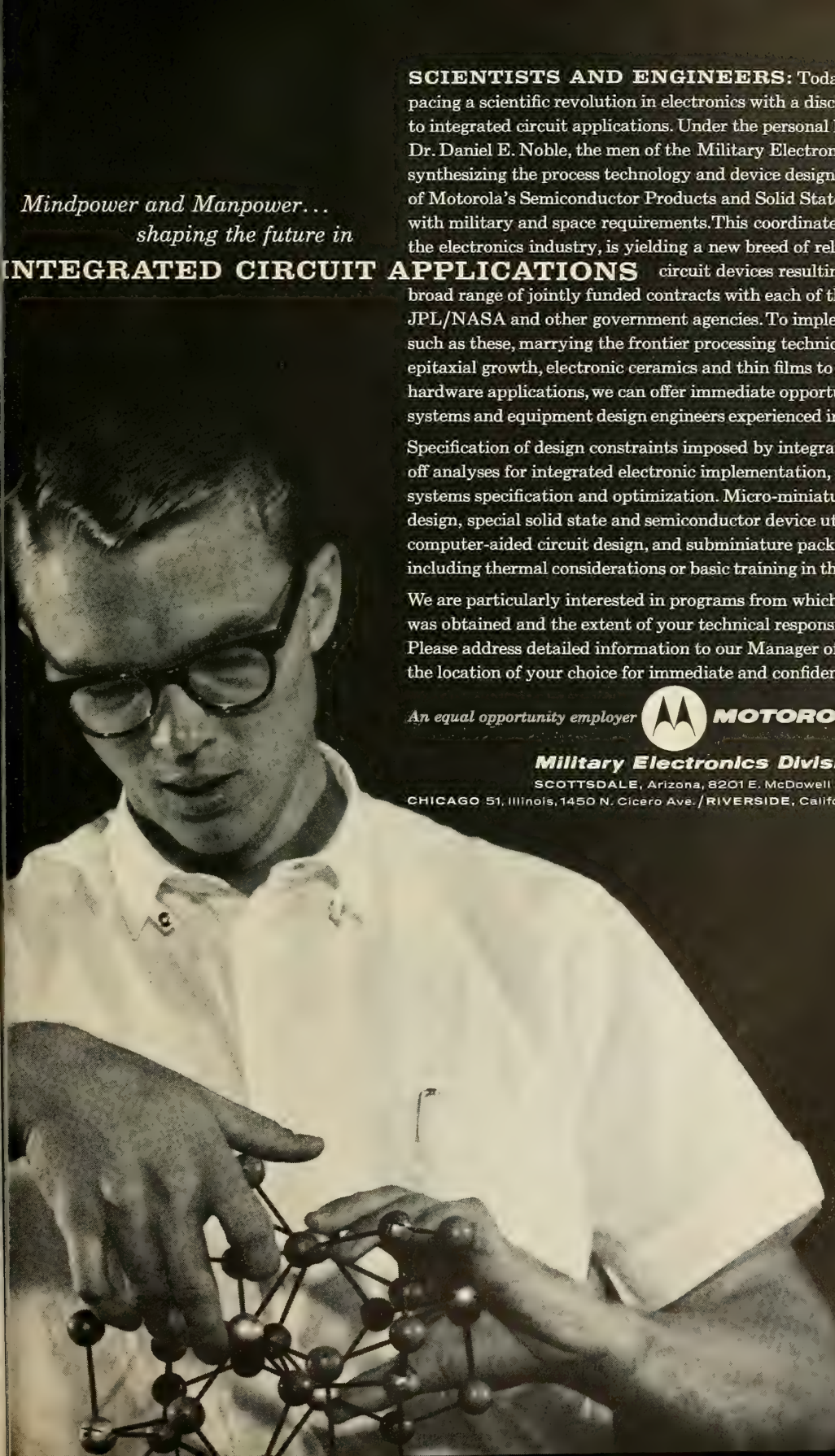
Specification of design constraints imposed by integrated circuits, trade-off analyses for integrated electronic implementation, and electronic systems specification and optimization. Micro-miniature transistor circuit design, special solid state and semiconductor device utilization, computer-aided circuit design, and subminiature packaging techniques, including thermal considerations or basic training in the solid state sciences.

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a variety of general-purpose digital computers. These computers are designed with maximum simplicity, commensurate with functional requirements and operate in their environment with highest reliability and long life. In space as well as at sea and in the air, Librascope computers pace man's expanding mind.

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# The Countdown

## WASHINGTON

### Schriever May Move to White House

Insiders say the successor to Gen. Maxwell Taylor as White House military advisor might be Gen. Bernard Schriever of Air Force Systems Command. This is seen as a shrewd Administration move to emphasize its attention to military space. It also would pave the way for Schriever to replace Gen. Curtis LeMay as AF Chief of Staff when the time comes.

### New Transit Stabilization System

*TRAAC* stabilization system, which uses the Earth's gravitational field for orientation, will be used on the Navy's operational *Transit* navigation satellite system. This, plus the elimination of completely redundant subsystems, will allow the Navy to reduce weight of the operational *Transit* from 175 lbs. to less than 100 lbs.

### National Guard to Get GAR-11's

Air National Guard units flying F-102 fighter interceptors in the Continental Air Defense system are to be armed with the *Falcon GAR-11*. The Hughes missile has a nuclear warhead as well as a greater range and improved guidance. The units are expected to be operational by January, 1964.

### Secret Report Favors Zeus

A top-secret report on the relationship between active and passive defensive measures reportedly is causing a re-evaluation of the Army's *Nike-Zeus* system by Administration officials. Major conclusion of the report: with both active and passive (fallout shelter) defense, casualties from a nuclear missile war could be reduced to 3% of the population. The study assumes *Zeus* protection for the 50 largest U.S. cities.

### AF Developing New Multi-Purpose Missile

Air Force has under development a new missile designed to provide both air-to-surface and air-to-air fire support. No details of the program are available.

### Skybolt Stellar Guidance Test Planned

First guided test flight of the Douglas *Skybolt* is set for late October. Fourth unguided flight is due later this month. The missile for the guided flight already is at Eglin AFB where its Nortronics stellar-inertial guidance unit is undergoing checks to determine whether an accidental scratch on the star-tracker window will prevent the unit from locking onto a planned reference star.

### SA-3 Embarks for Canaveral

The third *Saturn* launch vehicle has started the long ten-day trip from the Marshall Space Flight Center to Cape Canaveral. *SA-3* is expected to arrive at the Cape on Sept. 19. The launch is scheduled for mid-November.

### Four Major Shots Scheduled for October

October could be a heavy launch month for NASA. *S-55*, the Micrometeoroid Satellite, will be launched from Wallops Island. An *S-3* satellite will be launched from Cape Canaveral to measure energetic particles. Two communications satellites—the second *Telstar* and the first *Relay*—are scheduled for late in the month, although both may slip to November.

### Gemini Recovery Range Broad

Use of a Rogallo paraglider in Project *Gemini* will allow the spacecraft to maneuver over a range of 13-25 miles. The paraglider will be deployed at an altitude of 50,000 ft. and the glide will begin at 40,000. Landing speed will be about 70 ft. per second.

### Compromise Expected on NASA Budget

Look for the House and Senate early this week to compromise their differences over the NASA Fiscal '63 budget. With $40 million separating the two, it is expected they will split the difference. This will give NASA about $3.674 billion for expenditures in the current fiscal year.

### Syncom Hearings Due This Week

A House space subcommittee will hold hearings this week on the NASA *Syncom* communication satellite program. Hearings are set tentatively for Sept. 19 and 20. Witnesses from both NASA and Hughes Aircraft Co., the program's prime contractor, will be called.

## INDUSTRY

### Electronics Market Forecast

The electronics content of the FY '63 DOD/NASA budgets will total $8.6 billion, according to Electronic Industries Association President Charles F. Horne. He says the split will be roughly $7.9 billion for DOD, $0.7 billion for NASA.

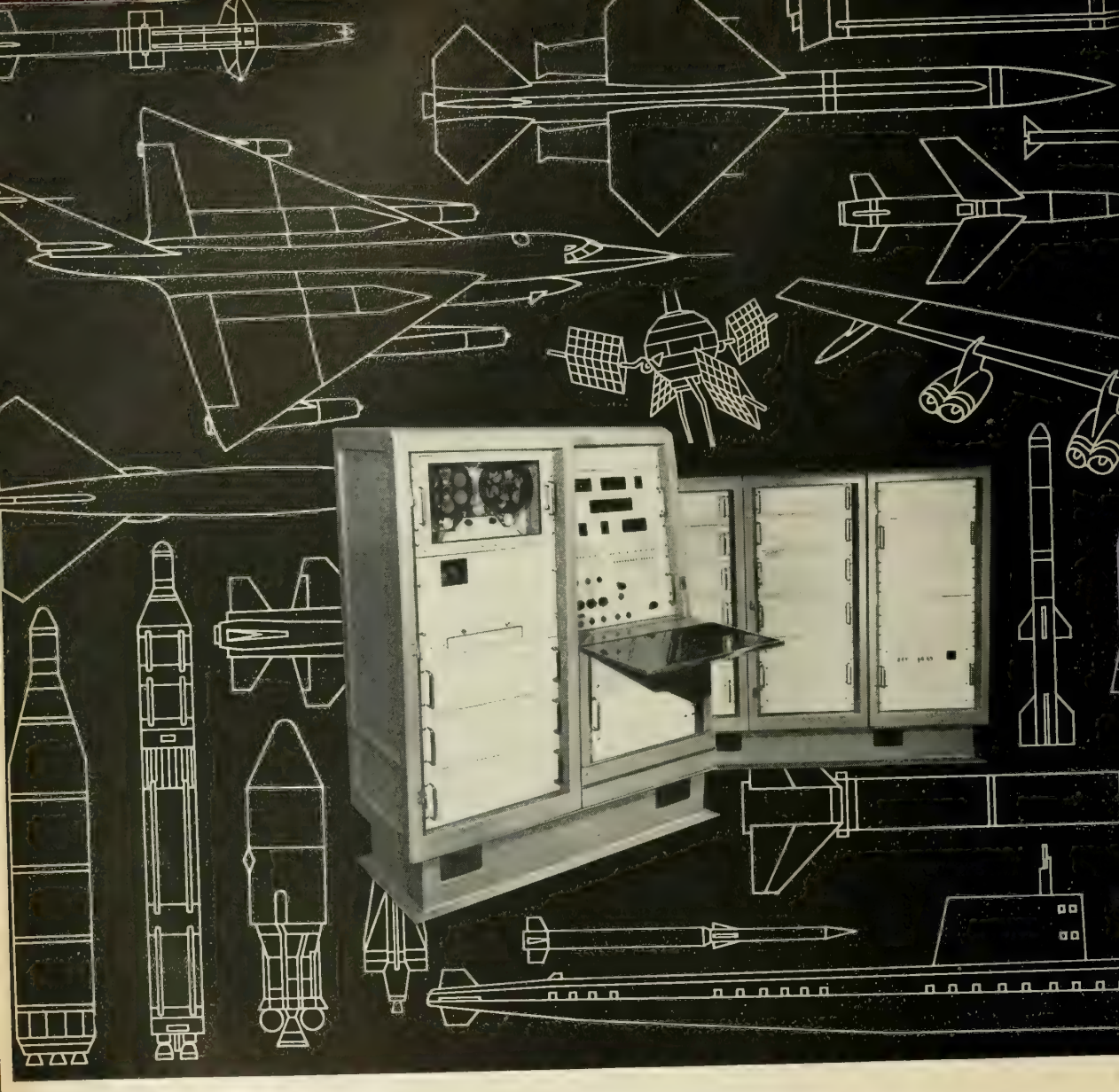
### GE Moves Major Division to Daytona

Continuing its extensive internal reorganization, General Electric has set up its *Apollo* department within the new Command Systems Division. Headquarters for CSD and the *Apollo* group will be Daytona Beach, Fla. The initial group of 200-300 persons may expand to 3,000 over the next few years.

## INTERNATIONAL

### British Study Manned Spacecraft

Britain's Ministry of Aviation has confirmed that a feasibility study of a manned spacecraft is under way. The Royal Aircraft Establishment has been at work on the project for 18 months. Design is an orbital fighter, not a rocket-launched capsule of the *Mercury* or *Vostok* type.



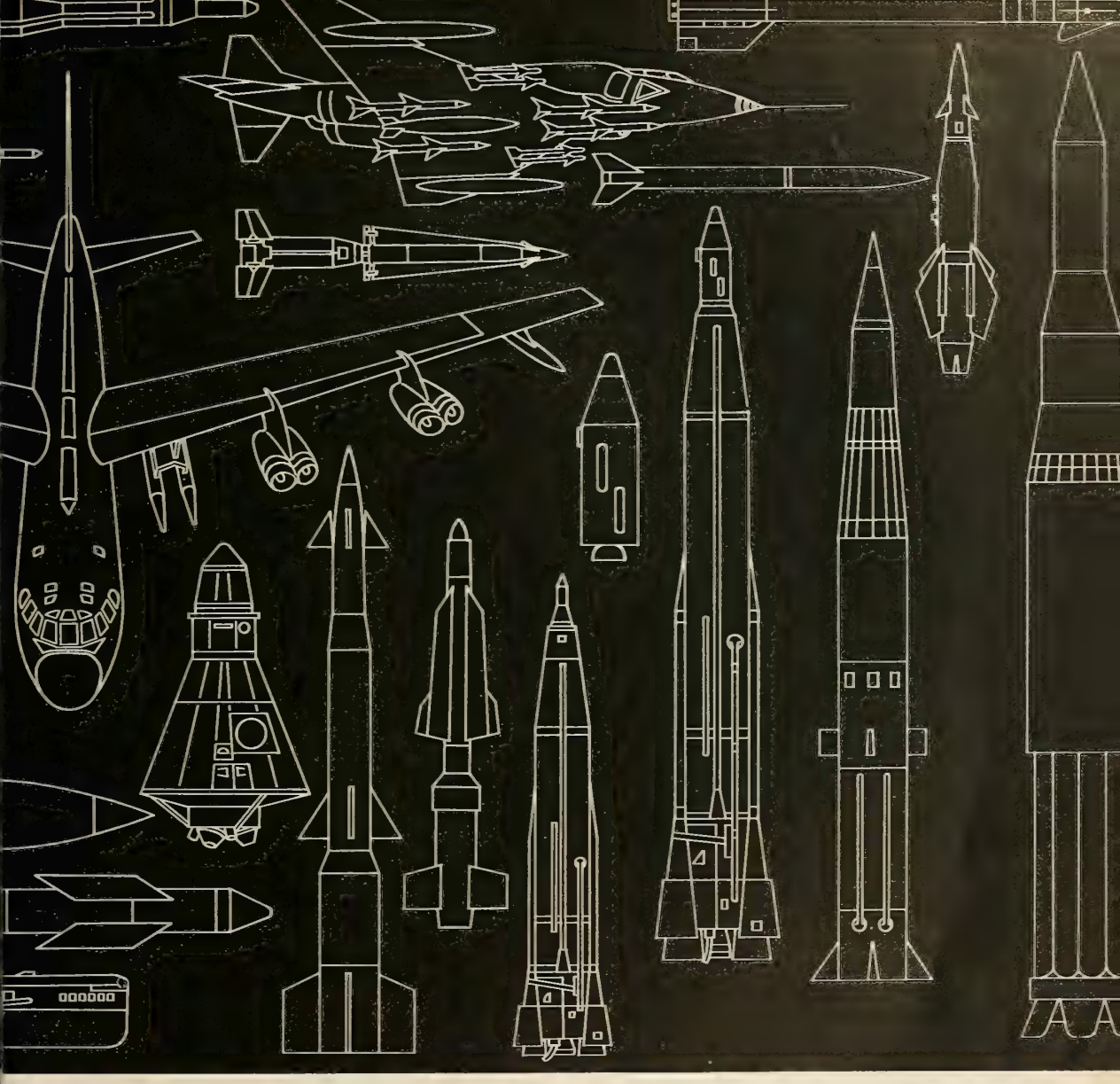
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For information on how E-P can best assist your operations in every area—whether undersea or on it, airborne, or in space—we invite you to write, call or visit us in Teterboro, N. J.

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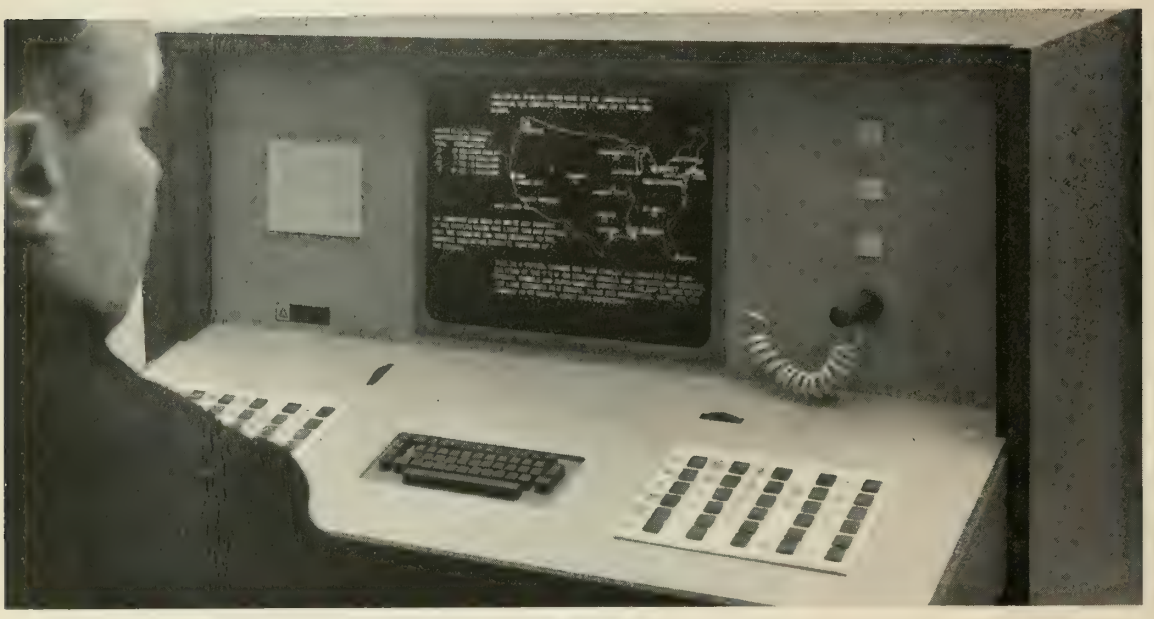
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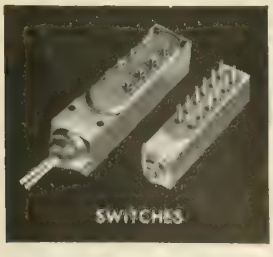
For one-shot applications, this Atlas Miniature Piston Actuator 1MT114 is used in missile and space vehicle applications to convert an electrical impulse to mechanical energy. For example, it is used as a safety mechanism . . . as a locking or releasing device . . . to prevent or permit rotation or linear travel . . . to perforate a container . . . or to activate a relay, latch, or mechanical load.

The piston moves $\frac{5}{16}$ in. ($\pm \frac{1}{64}$ in.) against a 20-lb. air bellows. Firing energy is 18.5 V with 10-ohms series resistance and 4-millisecond pulse. Approximate firing time is 10 milliseconds. The actuator is reliable in ambient temperatures from −65°F to +165°F, and it will withstand 300°F for one-half hour. Meets required MIL specs for resistance to shock, vibration and acceleration.

**Size:** Overall length before firing—0.725 in. max. Diameter—0.130 in.

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# How to put your finger on precise location

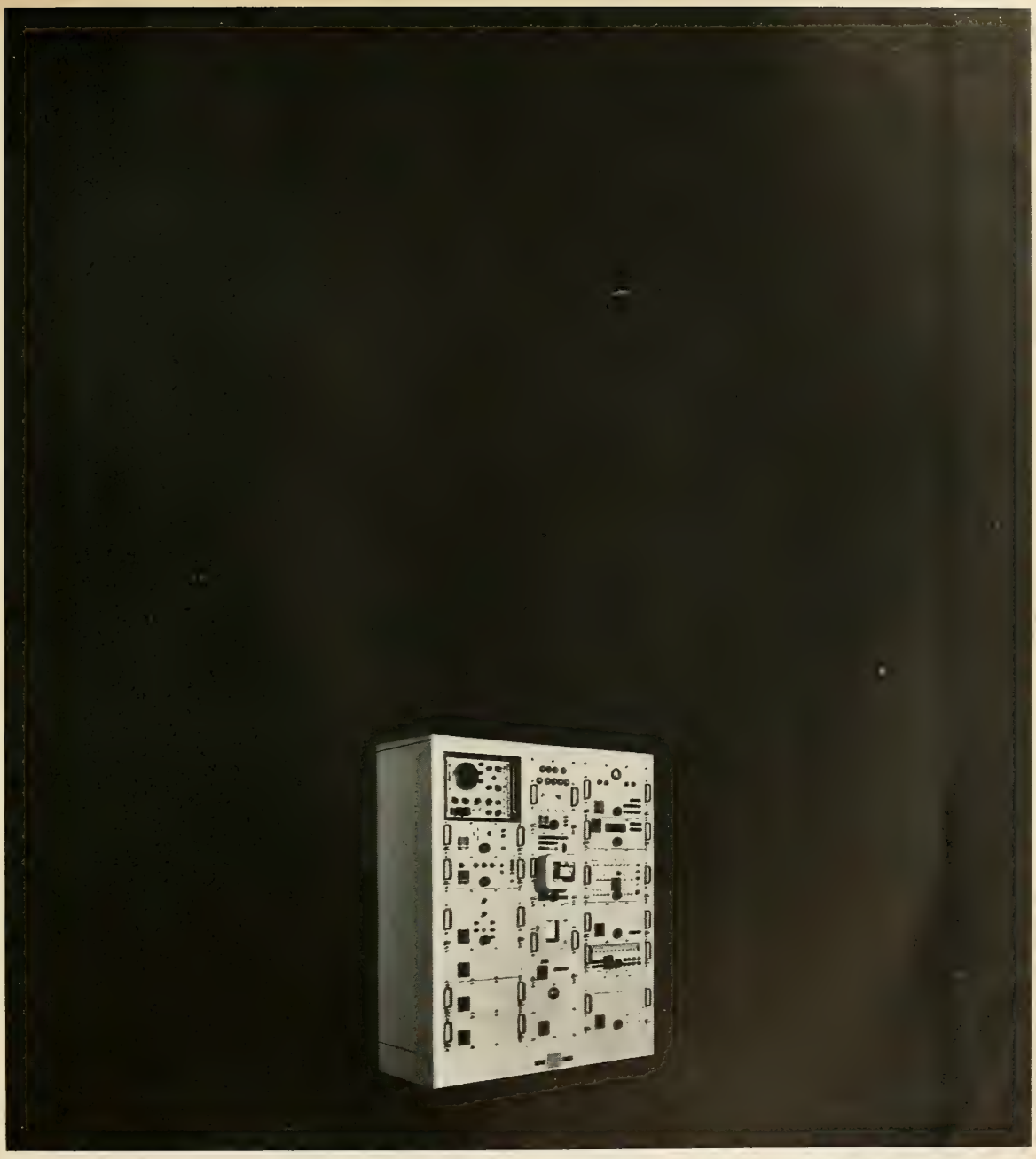


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## Blabbermouth

NARATE is an automatic radar test system developed for the Navy by Northrop. One of its main functions is to warn the radar operator when anything goes wrong with his equipment. But that's just the first step.

When it discovers a fault in the radar, NARATE can be programmed to find out what the trouble is, and isolate it down to the lowest removable unit. Or it can be directed to bypass the fault in order to continue the test.

NARATE has been tested at the Navy Electronics Laboratory, San Diego, for integration and compatibility with a complex air search radar. It is now installed aboard the USS Columbus for evaluation in fleet operations. Based on the proven Datico automatic test equipment concept, NARATE was developed for the Navy by the Nortronics Division of Northrop.

**NORTHROP**

# $22-Billion Market Through 1970

***Industry share may reach $19 billion; future shift in military space role would alter procurement picture***

THE OVER-ALL space electronics market is expected to exceed $22-23 billion for the remainder of the decade. Of this, nearly $19 billion will be available to industry.

Further, this over-all figure is expected to hold whether current funding trends continue or, as predicted by many, there is greater emphasis placed on expansion of the military role in space.

The direction ultimately chosen by the government over the next few years will, however, have a significant effect on the types of space hardware procured.

Should the military space role be emphasized, the present posture of passive vehicles will be reduced or even obviated. There can be an enormous increase in combatant possibilities in this environment. As a result, several orders-of-magnitude improvement will have to be made in tracking capabilities, sensors and packaging to meet the challenge. New techniques and new hardware will be needed for guidance and control, rendezvous, surveillance, and for ground command centers.

In the following market discussion, it must be understood that the tables represent the cleanest breakout of expenditures. Due to the complexity of major systems and the existing methods of procurement, distinct market categories are difficult to separate. Thus, there are some market overlaps that tend to exaggerate particular estimates.

• **Guidance & control**—By projecting through 1970 only those space systems firmly conceived and which bear a high probability of attaining planned production, the space guidance and control market exceeds $1.3 billion (see table).

This is believed to be a very conservative figure. It does not include advanced research on subsystems for G&C not now associated with particular programs. Nor does it allow for unforeseen expenditures which undoubtedly will occur on programs such as *Apollo*.

Assistant Air Force Secretary Brockway McMillan has estimated that the Air Force alone is spending roughly $200 million a year for G&C research. National Aeronautics and Space Administration G&C programs for advanced technology have been aimed primarily at the *Nova* program. Obligations in FY '62 approached $4 million.

Hardware for G&C systems comes high. For example, *Titan II* guidance (which will be modified for use in *Titan III*) is estimated to cost roughly $200,000 per unit, excluding GSE; *Saturn* guidance runs about $200,000 for each system and upwards of 50 vehicles may be required. Even scientific satellites require extensive stabilization: *OSO*—$180,000 each, *OAO*—$200,000 each and *OGO*—$200,000 each.

G&C requirements for *Dyna-Soar* could reach $50 million by 1970. What military expenditures might be for future manned vehicles is too foggy now to see. Many believe such programs will come into being. But so far, the Administration has a tight rein on any major military space move.

Requirements for both manned and unmanned lunar and planetary spacecraft guidance undoubtedly will set the pace for this industry through 1970 and beyond. The systems will be combinations of radio command, optical and inertial guidance equipment, depending upon the particular operational need.

The trend will be toward greater use of automatic digital data processing equipment. Stringent limitations on space, weight and power and the demands for extreme accuracy and reliability will dictate use of digital equipment because of its adaptability to microminiaturization. It then will be quite feasible to use redundancy and other techniques to achieve the desired reliability.

Stellar trackers will give way to star field correlators. All the data-taking operations required with star trackers will be eliminated as star fields are used to determine spacecraft altitudes and fixes. The low light level image orthicon under development by General Electric, for example, together with fiber optics and computers, will make possible a type of celestial pilotage with great utility and convenience. Horizon scanning and occultation techniques are readily and automatically integrated into this technique.

Lasers may be developed which will improve detection range and accuracy when navigating about man-made space objects. Systems like *Transit* will provide Earth and planet-centered refer-

TOTAL ESTIMATED SPACE EXPENDITURES
(in billions of dollars)

| Forecast Based On Military Space Build-up | '62 | '63 | '64 | '65 | '66 | '67 | '68 | '69 | '70 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| NASA | 1.8 | 3.7 | 5.0 | 5.5 | 6.0 | 6.0 | 5.7 | 5.5 | 5.0 | 44.2 |
| DOD | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.2 | 5.0 | 6.5 | 29.2 |
| TOTAL | 2.8 | 5.2 | 7.0 | 8.0 | 9.0 | 9.5 | 9.9 | 10.5 | 11.5 | 73.4 |
| Total Electronics Expenditures | 0.7 | 1.4 | 2.0 | 2.3 | 2.7 | 2.9 | 3.1 | 3.5 | 3.9 | 22.5 |
| **Forecast Based on Current Funding Trend** | | | | | | | | | | |
| NASA | 1.8 | 3.7 | 5.0 | 5.5 | 6.0 | 6.2 | 6.4 | 6.6 | 6.8 | 48.0 |
| DOD | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 3.8 | 4.4 | 5.0 | 26.7 |
| TOTAL | 2.8 | 5.2 | 7.0 | 8.0 | 9.0 | 9.7 | 10.2 | 11.0 | 11.8 | 74.7 |
| Total Electronics Expenditures | 0.7 | 1.4 | 2.0 | 2.3 | 2.7 | 3.0 | 3.3 | 3.6 | 4.0 | 23.0 |

ences for limited range navigation.

• **Communications** — Three urgent requirements exist for early development of communications satellites: military or national command and control; commercial telecommunications; and augmentation of communications from around the world to the ranges and missile/space control centers.

It is expected that total annual expenditures for communications satellite programs by the government will reach $2 billion by 1967 and from $3-4 billion by 1970. Dept. of Defense will account for about 70% of these expenditures, industry observers believe.

In a report published earlier this year by the Electronic Industries Assn., costs for the variously proposed commercial communications satellites were as follows:

**—$155 million**—20 medium-altitude satellites in random polar orbits.

**—$100 million**—2 pairs of synchronous-orbit satellites.

**—$185 million**—20 medium-altitude polar-orbit and 10 medium-altitude equatorial-orbit (random) satellites.

**—$135 million**—3 pairs of synchronous-orbit satellites.

Spaceborne equipment costs for each of the above system configurations was reported as $70, $75, $100, and $110 million, respectively.

The whole space communications field also includes satellite data links (telemetry), manned vehicle communications subsystems, and ground stations directly supporting such systems.

Total expenditures available to industry are shown by these estimated trends:

**—1962** — $235 million (NASA, $145M; DOD, $90M).

**—1966** — $335 million (NASA, $185M; DOD, $150M).

**—1970** — $575 million (NASA, $225M; DOD, $350M).

The R&D-to-production ratio is about 3:7.

• **Tracking & data acquisition** — NASA's funding for FY '63 in these two areas is up to $158 million, or more than $60 million over last year's figure. Over $90 million of this is scheduled for systems development, equipment and components.

One-third of the systems development money will be for new systems ($5.3 million). The space agency will develop new-data acquisition, aiming to substantially reduce hardware volume, power, and complexity and at the same time increase reliability, maintainability and operating simplicity. A secondary aim is to reduce operational facilities and utility costs.

A portable data acquisition is required to support the *EGO* (Eccentric Geophysical Observatory) satellite program.



*CORE-PLANE memory, under development for the Gemini capsule guidance computer, is examined by IBM Gemini program manager C. Del Babb and engineering manager I. Walsh at IBM's Space Guidance Center.*

Other new systems will include:

—An *Apollo* tracking system.

—A high-speed, high-capacity ADP system having almost fully automatic data reduction capability.

—A new digital (PCM) command system for spacecraft which will permit real-time data handling. (System will be used to support *OGO, OSO* and *Relay*.)

More than $20 million will be required for equipment and components for the Satellite Network and nearly $37 million to expand the Manned Flight Network, according to NASA.

Another $17 million will be used to enhance the capability of the Deep Space Instrumentation Facility (DSIF) —primarily for automatic checkout and calibration equipment, antenna modifications, and for the addition of multichannel receivers and automatic detection and frequency acquisition gear.

• **Military tracking & ranges**—Most military space tracking and data acquisition efforts are associated with SPADATS (Space Detection and Tracking System) and the three national missile/space ranges. SPADATS is supported by the Air Force's Space Track program (496-L) for system updating and expansion. Funding is expected to range from $80-100 million a year at least through 1970.

It is impractical to separate the space portion from the missile/space support effort at the various ranges. However, it is believed that roughly 20% of space expenditures during the next three years will be for range instrumentation to support manned space programs.

One leading expert forecasts that expenditures at the Atlantic Missile Range will reach 80% of total range expenditures by 1965 (it has accounted for from 65-75% in the past). Pacific Missile Range will account for about half the remaining growth.

The majority of growth at the

SPACE ELECTRONICS MARKET AVAILABLE TO INDUSTRY *
(in millions of dollars)

| | '62 | '63 | '64 | '65 | '66 | '67 | '68 | '69 | '70 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| DOD: | | | | | | | | | | |
| Spaceborne | 150 | 220 | 250 | 310 | 440 | 610 | 750 | 900 | 1000 | 4,630 |
| Ground | 110 | 160 | 180 | 220 | 310 | 440 | 540 | 640 | 710 | 3,310 |
| NASA: | | | | | | | | | | |
| Spaceborne | 180 | 340 | 480 | 600 | 760 | 900 | 990 | 1080 | 1180 | 6,510 |
| Ground | 120 | 230 | 330 | 420 | 520 | 620 | 680 | 740 | 810 | 4,470 |
| TOTAL | 560 | 950 | 1,240 | 1,550 | 2,030 | 2,570 | 2,960 | 3,360 | 3,700 | 18,920 |

* Based on current funding trend. Excludes govt. salaries, expenses, in-house R&D, construction.

ranges during the next few years will be represented by a general expansion of tracking and launch facilities. A sizable investment also will be made by the Air Force for as many as 10 tracking vessels (ARIS). Eglin AFB will acquire related facilities to support the *X-20* and Space Track R&D programs.

The electronics market for ranges is expected to exceed $400 million a year by 1965. The following is a breakdown of major electronic R&D expenditures by DOD for FY '63 at all the ranges:

—**$750,000** — tracking equipment (primarily pulse-type) and interferometric electromagnetic devices. (This represents a sharp drop from the $12 million in 1962 and is blamed by many on short-sighted planning.)

—**$500,000**—optical tracking

—**$7.5 million**—telemetry

—**$1.1 million**—other (data transmission, processing display and timing systems plus special purpose computers.)

• **Scientific instrumentation**—Costs for satellite instrumentation, according to NASA, vary from 40-80% of total payload. The average is about 70%.

NASA's scientific satellite program is funded this year (FY '63) at nearly $150 million, lunar and planetary exploration vehicles at more than $225 million, applications satellites at over $110 million. Thus, for just these three spacecraft categories, over $300 million will be required for necessary instrumentation R&D and hardware.

Instrumentation for Air Force satellites and the Navy's *Transit* add a substantial sum to the total market figure.

Conservative industry estimates covering this field place the FY 1963 total at $330 million with the annual figure growing steadily to $500 million by 1970.

• **Other space markets**—Checkout is big business today. Considering direct and associated DOD and NASA space requirements, more than $3.5 billion will be spent over the next eight years. Currently running $375-400 million a year, the total market is expected to reach about $500 million a year by 1970.

Another important market is in trainers and simulators. Breakout is difficult, as such systems are usually associated with expenditures for other systems or programs. Best estimates place combined DOD-NASA expenditures at about $200 million for FY 1963. Steady growth is expected through 1970 to $400 million.

Comparatively small, the space auxiliary electric power market is nonetheless an important (and consistent) one. It is currently running about $24 million a year and will rise only slowly to about $27 million annually in 1970. ⁂



*NEW MINIATURE four-gimbal inertial platform by Kearfott was designed for space guidance. The package weighs only 14.3 pounds, as compared with the 2700-pound MIT system built in 1953. The new unit occupies less than ⅓ cubic feet of space.*

## GUIDANCE AND CONTROL EXPENDITURES THROUGH 1970 *

| (in $ millions) | '62 | '63 | '64 | '65 | '66 | '67 | '68 | '69 | '70 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Ranger | 1.0 | 2.5 | — | | | | | | | 3.5 |
| Surveyor | 3.0 | 3.0 | 1.0 | 0.5 | — | | | | | 7.5 |
| Prospector | — | 0.5 | 2.0 | 5.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 22.5 |
| Mercury | 3.0 | 2.0 | — | | | | | | | 5.0 |
| Gemini | 5.0 | 12.0 | 10.0 | 3.0 | — | | | | | 30.0 |
| Apollo | 12.0 | 33.0 | 27.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 20.0 | 242.0 |
| Mariner | 1.0 | 14.0 | 2.0 | 1.0 | — | | | | | 18.0 |
| Voyager | 1.0 | 3.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 18.0 |
| Scout (NASA) | 1.0 | 4.5 | 5.0 | 5.5 | 5.5 | 5.5 | 5.5 | 5.0 | 4.5 | 42.0 |
| Blue Scout (AF) | 5.0 | 6.0 | 9.5 | 10.5 | 10.5 | 10.5 | 10.5 | 9.5 | 8.5 | 80.5 |
| X-20 | 15.0 | 15.0 | 10.0 | 5.0 | 5.0 | ? | | | | 50.0 |
| Medium-Large Launch Vehicles: Delta, Thor-Agena B, Atlas-Agena, Atlas-Centaur, Titan II, Titan III. | 29.0 | 39.0 | 44.5 | 55.5 | 57.5 | 57.5 | 58.5 | 59.0 | 59.0 | 459 5 |
| Very Large Launch Vehicles: Saturn C-1, Saturn C-5, Nova, Rover/Nova. | 13.5 | 21.0 | 25.5 | 30.0 | 35.0 | 31.0 | 31.0 | 31.0 | 30.0 | 248.0 |
| Orbital Rendezvous | 1.0 | 1.5 | 1.5 | 1.0 | ? | | | | | 5.0 |
| Attitude Stabilization only: Comm., Meteorological, & Scientific Satellites plus Midas, Samos, Transit. | 2.7 | 3.0 | 12.0 | 13.5 | 11.5 | 12.0 | 12.0 | 12.0 | 12.0 | 90.7 |
| TOTAL | 93.5 | 160.0 | 152.0 | 162.5 | 162.0 | 152.5 | 152.5 | 150.5 | 137.0 | 1322.5 |

* Figures include sensors, support equipment, displays, data processing equipment.

# NASA, DOD Want More Contractors

***Major effort to diversify represents FY '63 opportunity for firms not yet taking part in national space program***

FISCAL 1963 will present golden contracting opportunities for electronics firms not yet taking part in the national space program.

National Aeronautics and Space Administration and the Dept. of Defense are making a major effort to diversify and increase the number of their contractors. This will be particularly true in electronics.

The new trend in federal space procurement stems primarily from the desire to increase the military industrial base and to gain more public support.

"NASA is trying to get more companies into its programs and not concentrate its work with a few contractors," declared NASA procurement chief Ernest W. Brackett.

He added that NASA is also trying to bring more companies into its subcontract work.

"A great deal of effort is being made to place business in labor surplus areas and to spread government contracting into sections of the country which are not receiving much of this business. I can foresee that prime contract proposers who offer to place subcontracts in those areas are going to receive favorable consideration," the procurement chief said.

DOD—with about 80% of its Fiscal '63 budget going to industry—began last June an in-depth study to determine if the nation's existing research and development capacity is being used effectively.

Disclosure of the study was accompanied by a DOD statistical report on the "Changing Patterns of Defense Procurement," which revealed that 75% of Fiscal '61 contracts went to firms in California and East Coast states.

While indicating DOD's intention to do something about the imbalance, the report noted that "local initiative seeking defense business must direct itself to the creation of capability responsive to the exacting needs of modern warfare. Communities which fail to recognize this fact, and which fail to energize and mobilize their institutions to adjust to it, cannot reasonably anticipate a major role in future defense procurement."

The same reliance on technical capability in selecting contractors was echoed by Brackett in discussing NASA contracting policies.

"Where research and development is the subject of procurement and the success of the program depends on securing the best item that can be developed," he said, "we feel we must place a contract with the company that appears to have the greatest possibility of giving us that item.

"In research and development source selection," he continued, "technical features get the most weight in contractor selection."

Thus, it is clear that electronic firms wishing to get into the space business must make their technical capabilities known to the government agencies involved.

## NASA ELECTRONICS

At NASA, this can be handled in two ways:

A firm with a new technical proposal should send it to the Office of Research, Grants and Contracts, at NASA headquarters in Washington. The office will send the proposal on to the technical section concerned. If the technical experts feel it is feasible and if funds are available, a contract will be awarded.

Electronics firms wishing to bid on NASA contracts should get on the "bidders' lists" maintained separately by each space agency field center.

A breakdown of the NASA centers and their procurement personnel follows:

- **Jet Propulsion Laboratory**—Pasadena, Calif. This center is responsible for NASA's unmanned lunar and planetary exploration programs. This includes the *Ranger, Surveyor, Mariner,* and *Voyager* spacecraft programs. Its chief procurement officer is T. W. Candee and G. R. Lawrence is its small business specialist.

- **Ames Research Center**—Moffett Field, Calif. Ames is primarily concerned with basic and applied research in many areas including atmospheric re-entry for manned satellites, boost-glide vehicles, proposed manned interplanetary and lunar craft, ballistic missiles and life support. Chief procurement officer is A. S. Herzog and the small business specialist is Donald E. Davis.

- **Goddard Space Flight Center**—Greenbelt, Md. Development of space science satellites and tracking and data acquisition and reduction are the two main responsibilities of this center. Gordon H. Tyler is the top procurement official and Harry T. O'Toole serves as the small business specialist.

- **Manned Spacecraft Center**—Houston. MSC is involved in the development operations in the three U. S. manned spaceflight programs, projects *Mercury, Gemini* and *Apollo*. This includes such electronic components as space guidance, communications and orbital rendezvous instrumentation. Firms should contact Dave W. Lang, Jr., chief procurement officer, and small business specialist, H. T. Christman.

- **Marshall Space Flight Center**—Huntsville, Ala. MFSC directs all of NASA's launch vehicle programs including the *Centaur, Saturn, Advanced Saturn* and *Nova* boosters. Development of the rocket engines which power the launch vehicles is also part of Marshall's responsibility. Chief procurement officer is Wilbur S. Davis and James S. Morrison is the small business specialist.

- **Launch Operations Center**—Cape Canaveral, Fla. LOC is responsible for

all of NASA's manned space and almost all of its unmanned satellite and spacecraft launchings. Electronic equipment procured by the center includes ground support equipment and communications for the launch complexes and control center. Gerard A. Michaud is the chief procurement officer and Carl J. Dahl is the small business specialist.

• **Lewis Research Center**—Cleveland. This center is primarily responsible for basic and applied research in chemical rocket engines, nuclear rocket engines, electrical propulsion systems, power generation systems and space environmental system. Firms should contact John Biggs, chief procurement officer, and Norman C. Prahst, small business specialist.

• **Wallops Station**—Wallops Island, Va. This center serves as the major launching point for satellites using NASA's *Scout* booster and many sounding rocket programs. Chief procurement officer is Louis T. Birch and Robert H. Bradford is the small business specialist.

• **Flight Research Center**—Edwards AFB, Calif. The X-15 rocket plane program is the primary work at this center, but most of NASA's small effort in the Air Force *Dyna-Soar* program is also located there. Morris E. Bowling is chief procurement officer and Lloyd J. Walsh is the small business specialist.

Two other space agency centers, NASA headquarters and the Western Operations Office, are almost completely restricted to contract management.

## MILITARY ELECTRONICS

Reliability, simplicity and maintainability are three key words being stressed not only in weapons systems development but in procurement of military space electronics as well.

In the words of one Air Force official, it is the responsibility of a contractor "to deliver a product that fulfills its whole mission; not a product with the greatest mass fraction or the lightest autopilot or the most transistors, but a product that does what it is supposed to do when it is called upon to do it."

An example of the reliability being designed into future space systems is the *Titan III* which Defense officials expect to provide an almost instantaneous launch capability "without the tender loving care of a hundred technicians for six weeks."

Realization that electronic systems have been too complex and therefore less reliable and maintainable under field conditions has already had its effect on DOD procurement and systems development.

Use of incentive contracting is a principle means by which DOD expects to achieve simpler, more reliable systems. In evaluating a particular system, points for performance will be weighed in favor of reliability and maintainability as much as for range, speed or other more conventional performance parameters.

Within the Air Force, this increased emphasis has resulted in the establishment, within weapons development programs, of specialists in reliability and maintainability. In fact, the Air Force Systems Command has underscored the importance which it attaches to reliability by offering a master's degree in reliability engineering at its Institute of Technology at Wright-Patterson AFB, Ohio.

• **Service breakdown**—Procurement of military space electronics is largely the responsibility of the Air Force, with the Navy and Army participating to a far lesser extent. Therefore, a supplier interested in selling to the military should first insure that he is included in the Air Force's source file.

To do this, a firm should obtain the standard Form 220, "Research and Development Source Information" from any Air Force Systems Command procurement Office. These forms should be sent directly to Headquarters, AFSC, Andrews AFB, Washington 25, D.C. The director of AFSC procurement will disseminate the information to all development divisions.

Responsibility for the procurement of space systems is centered in the Deputy Commander for Aerospace Systems (DCAS)—located at 5800 Arbor Vitae St., Los Angeles 45, Calif. (Building 4). Within DCAS, the Contractor Relations and Small Business office provides contractors with advice on AF space needs, and evaluations of company capabilities. It also adds firms to its source list.

When procurement action on a system is initiated, the Contractor Relations and Small Business office screens its files for qualified bidders and submits the list to the Source Selection board. Qualified firms are then asked to bid and their proposals are evaluated by the board, which recommends to DCAS or higher headquarters the best qualified contractor.

Closely paralleling the AFSC procedures, the Navy's space electronics procurement is concentrated in its Bureau of Weapons. Firms wishing to bid on Navy projects must submit a Standard Form 129 to the Department of the Navy, Chief, Bureau of Naval Weapons, Code: NCS-41, Washington 25, D.C.

Procurement actions for the Army—limited almost exclusively to ground stations for the DOD communications satellite programs—are handled through the Ft. Monmouth Procurement Office. Interested firms should contact the office's industrial liaison and small business representative, Mr. Charles Hoyt in the Office of the Director of Procurement Operations, Army Signal Agency, Fort Monmouth, N.J.

Agencies within the Air Force Systems Command directly concerned with military space electronics include: Electronic Systems Division, Rome Air Development Center, Avionics Directorate of the Aeronautical Systems Division and the Air Proving Ground Center.

Procurement at the Electronic Systems Division centers around equipment for all command and control systems including communications, data processing, data displays, tracking and detection. In addition, ESD handles applied research for all new command and control systems. Procurement contacts at ESD are: Mr. John Condon, Mr. Norman Mullen, Small Business and Contractor Relations and Sources, L. G. Hanscom Field, Mass.

Rome Air Development Center is interested principally in ground-based electronic systems and equipment, including all facets of infared and radar detection and tracking. In addition, RADC is concerned with laser data transmission techniques, advanced space communications and antenna development. RADC procurement contact is: Mr. John Vella, small business specialist, Contractor Relations and Sources, Rome Air Force Development Center, Griffis AFB, N.Y.

The Avionics Directorate of the Aeronautical Systems Division is concerned with all types of inertial and stellar guidance systems and components, flight programers and data processors as well as telemetry subsystems data conversion systems and transducers. ASD is also conducting a major effort in the fields of thermionics, molecular electronics and bionics. Procurement contact is: Miss Betty Weisbrod, Contractor Relations and Sources, Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

The Eglin AFB Air Proving Ground Center is mainly concerned with suitability testing of AF weapons systems. It also conducts an extensive program of space probe launchings. Its main procurement interests in the space electronics field are telemetry, instrumentation and data processing components. The main procurement contact is: Mr. J. V. Leftwich, Contractor Relations and Sources, Air Proving Ground Center, Eglin AFB, Fla.

Centers mainly concerned with procurement of electronic components, instrumentation and data processing and handling equipment are: AF Flight Test Center at Edwards AFB, Calif.; AF Missile Test Center at Patrick AFB, Fla.; AF Missile Development Center at Holloman AFB, N.M. and the Arnold Engineering Development Center at Tullahoma, Tenn. ⠿

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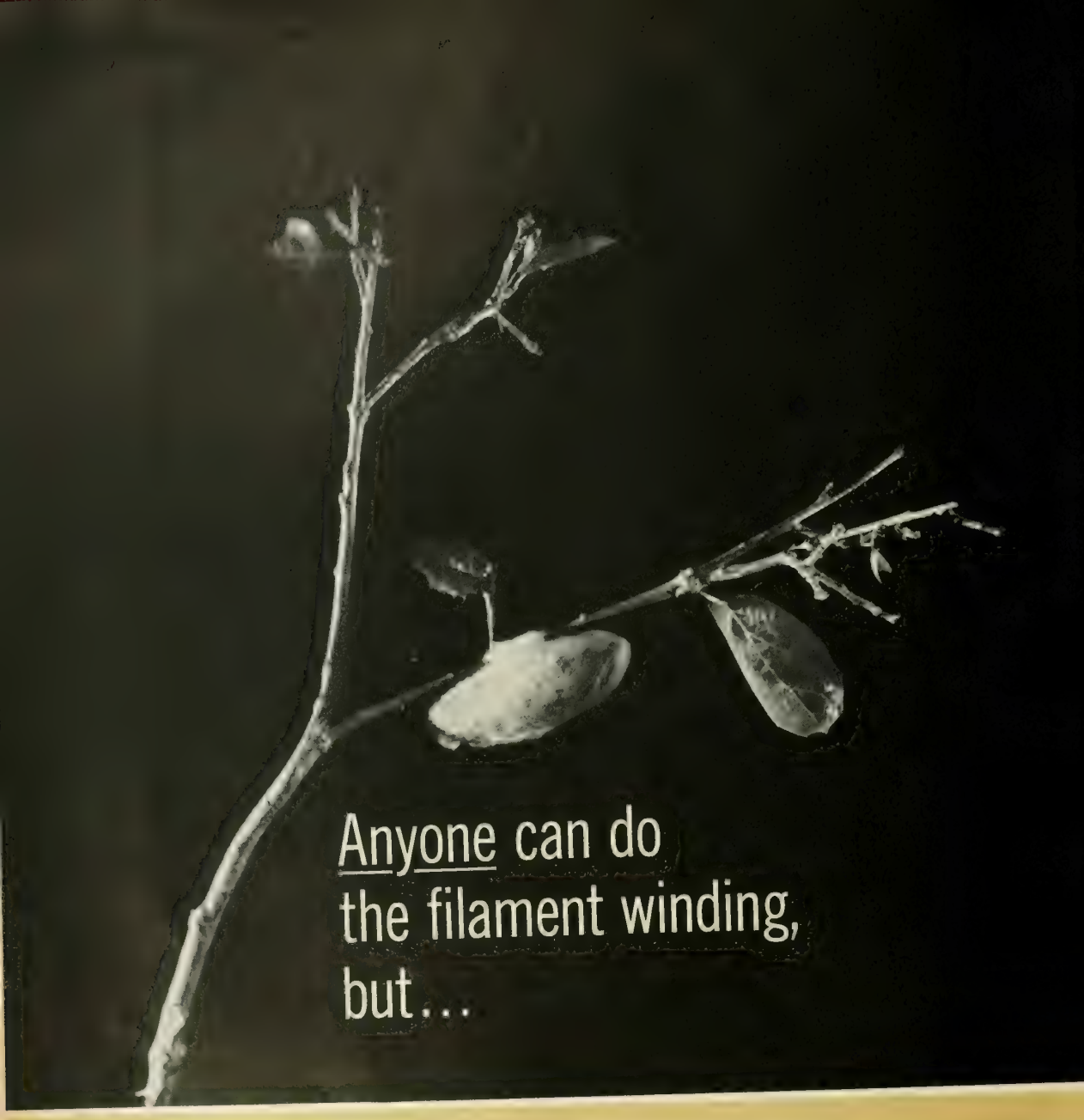

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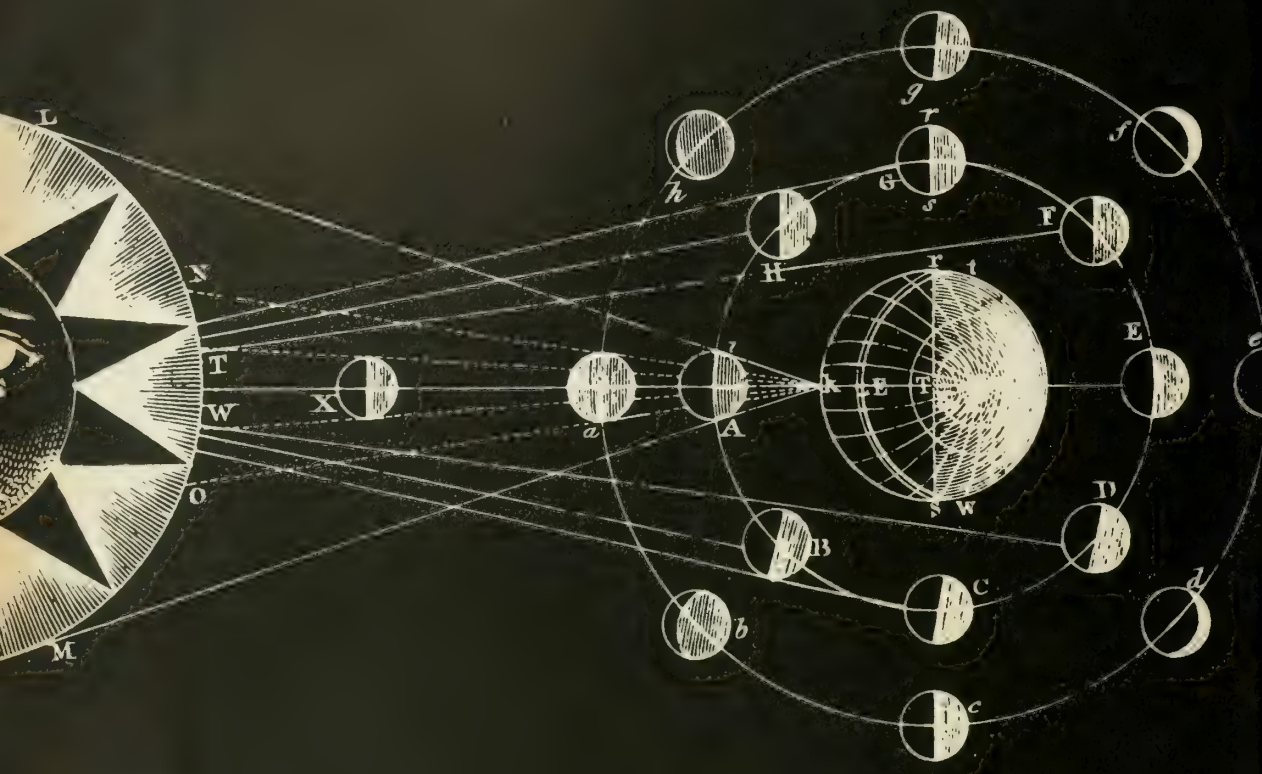
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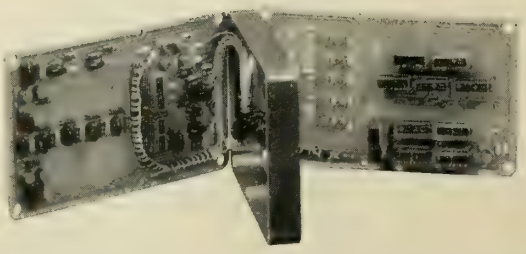

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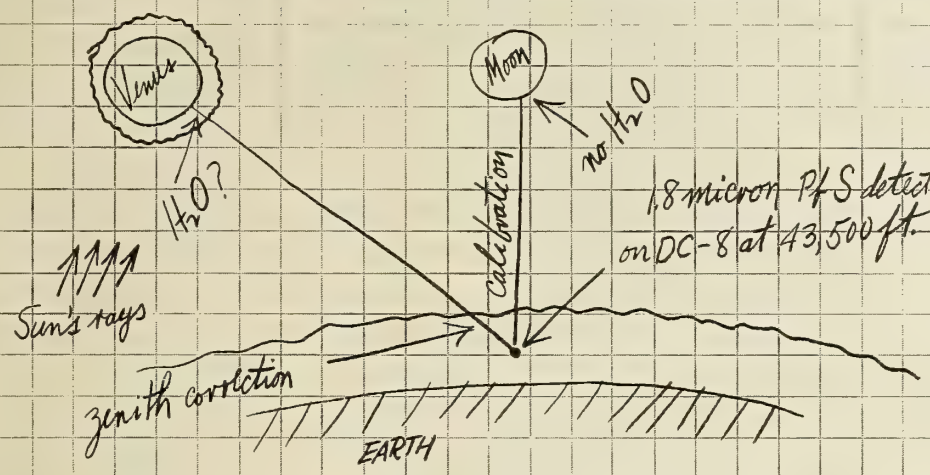
**Here is one example:** This seven-ounce PCM digital data signal con ditioner has the semiconductor network equivalent of 2,215 com ponents. Logic is performed by *Solid Circuit** semiconductor net works — 102 of them. This equipment has already been delivere to the Department of Physics and Astronomy at the State Univer sity of Iowa for an EGO satellite experiment.

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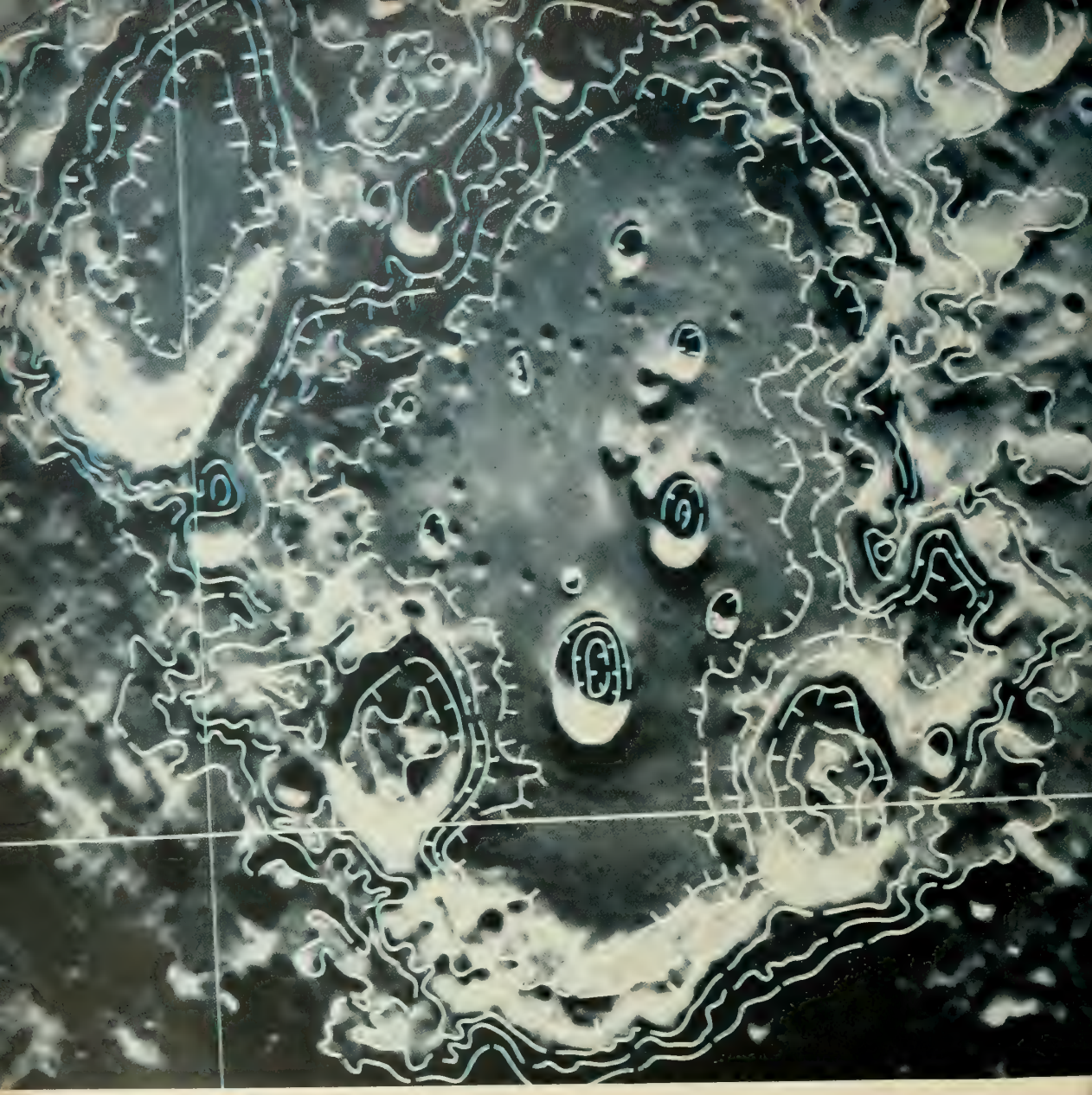
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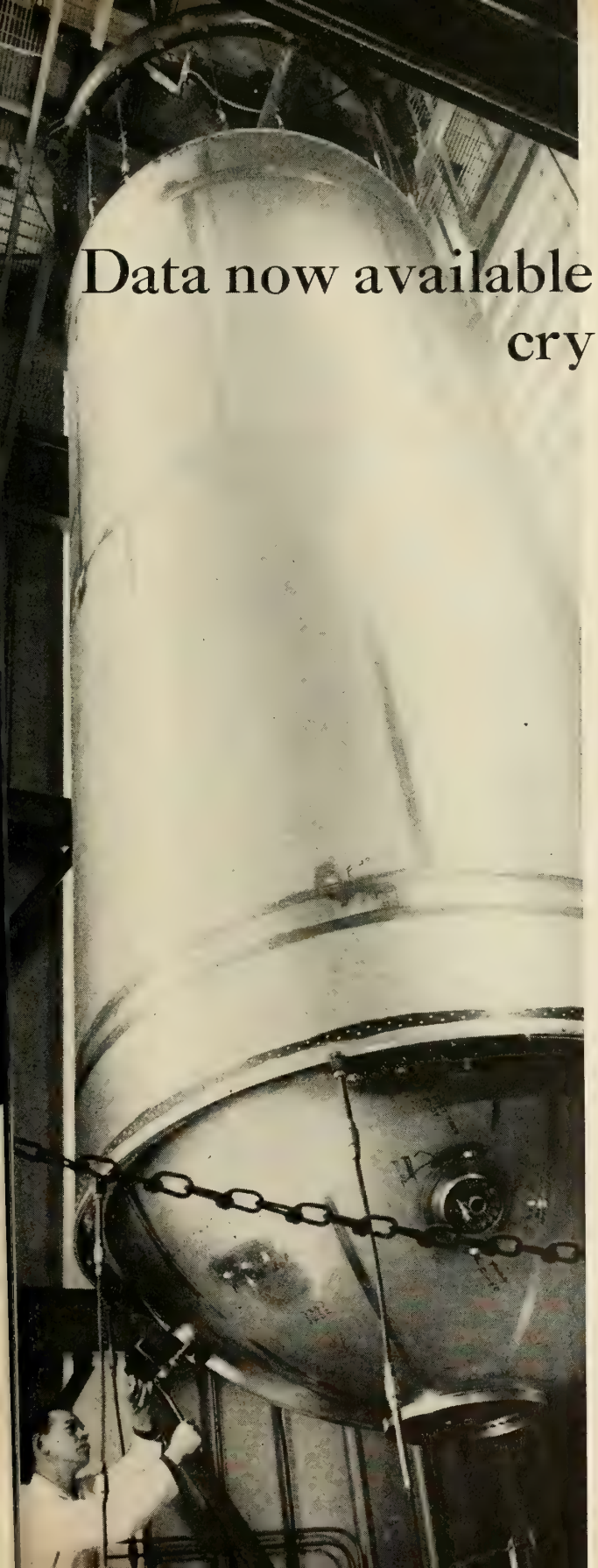
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**Some specifics.** The liquid hydrogen tank shown here was built and successfully hydrostatically tested by Beech Aircraft Corp. Capacity: 7,000 gallons. It was fabricated from sheet supplied by Titanium Metals Corporation of America to less than AISI tolerances, in thicknesses ranging from 0.014 to 0.025 inches.

**Cryogenic alloys.** The alloy used was Ti-6A1-4V ELI, one of two alloy grades advanced by TMCA specifically for liquid hydrogen service. The other grade is Ti-5A1-2.5Sn ELI. The designation ELI stands for Extra-Low Interstitials. Typical properties of these grades at –423F:

**Ti-6Al-4V ELI:** tensile strength, 263 ksi; yield strength, 248 ksi; notch tensile strength, 211 ksi; elongation, 7%.

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# More Launches Will Tax Techniques

***Reference satellites, more sophisticated radar, lasers could contribute to needed state-of-the-art advancement***



*THIS ACCURATE antenna being built at Collins Radio Co.'s Richardson, Tex., plant will go into operation soon. One of its first tasks will involve experiments with Echo II, scheduled for launch later this year. The antenna has a 60-ft. dia. parabolic reflector.*

THE ACCELERATING U.S. space program, which will send more satellites and deep space probes into simultaneous operation, has pointed up the need to extend the state-of-the-art of vehicle tracking and control.

Here are just a few areas in which technological advancement could assist this extension:

—Reference satellites to calibrate tracking equipment.

—Greater automation in tracking and control system stations.

—More sophisticated radar, particularly spaceborne systems.

—Use of the optical frequencies opened by development of the laser.

• **Current equipment** — Satellite tracking equipment in current use varies from simple angle or Doppler measurements like those used in *Vanguard* and *Transit* to the complete radar position measurements used in the *Discoverer* and *Mercury* programs. Present state-of-the-art for satellite tracking is roughly 15 ft. in range, one ft./sec. in range/rate and 0.005 degrees or 0.1 milliradian in angle measurements—for angles above 10 degrees in elevation.

One advanced system, SPANDAR, an S-band radar, is being tested by NASA. The system has a 60-ft.-dia. antenna, and is reportedly capable of skin-tracking a 1-sq.-meter target at 600 mi. It can beacon-track to over 5000 mi. with a range accuracy of less than 10 yards. Tracking is done by conical scan at a 7.5 cps rate.

The Earth's atmosphere places limitations on single tracking equipment. The effects can be corrected in the 3000- to 6000-mc. region to about 0.02 to 0.05 milliradians in angle and 2-3 ft. in range —provided the elevation angle is greater than 10°.

To achieve these accuracies, there must be some means of calibrating tracking equipment to an equally high degree. The most promising method is use of a calibration satellite similar to *Transit* with its position known to within 500-600 ft. Calibration is now accom-

plished using an airborne beacon.

A reference satellite could help all stations in a tracking network. A principal advantage is that short-term effects of space propagation paths and Earth site conditions could be taken into account—solar cycle, Earth weather conditions and the proximity of noise sources. Another advantage would be a readily available radio source for routine performance checking of the entire tracking and control network.

Specialists in satellite tracking believe the principal future objective should be development of more accurate prediction techniques based on less tracking data. It would then be possible to computer-service a given satellite about once a month, updating its orbit ephemeris to an accuracy sufficient to meet all antenna acquisition or data indexing requirements for the next month. This is particularly true for high-altitude orbits where atmospheric drag coefficient variations are less significant.

In this system, a central computer would use preselected blocks of tracking data from the remote stations for updating the orbit ephemeris. The updated data, in turn, would be relayed to each tracking station where a local computer would compute antenna-pointing data required for scheduling the local station and its equipment. Thus a few computers could service many satellites with minimum data flow between tracking sites and the central computer.

• **Deep space probes**—Deep space probes have a common characteristic—the transmission of reliable information over distances which may vary from 300 million to more than 30 billion mi. If it is possible to communicate over these distances, it is possible to track.

The choice of an optimum frequency for a space-vehicle-to-Earth link is based upon a parametric study of background noise, atmospheric and water vapor absorption—to minimize the required transmitter power and maximize system range.

Some recent studies indicate that vehicle antenna size and maximum gain of ground antennas may have become limiting factors. This also indicates that optimum frequency choice is in the area of 2-3 kmc.

Frequencies for deep space missions fall into two general categories—ground transmitter and space transmitter. The NASA/JPL Deep Space Instrumentation Facility (DSIF) is using 890 mc. for Earth-to-spacecraft transmissions and 960 mc. for transmissions from spacecraft. All DSIF stations will phase into assigned space communication bands next year, using 2290-2300 mc. for spacecraft-to-Earth communications and 2110-2120 mc. for Earth-based transmissions.

A typical receiving system might then consist of a 60-ft. antenna with a parametric amplifier. A space vehicle 300 million mi. away equipped with an expandable 16-ft. antenna could transmit information over a 16-cps band. But for most applications, this is a rather slow rate.

To increase the bandwidth and information rate without an increase in size, weight, or power requirements of the space vehicle, designers are considering one or more of three alternatives—an increase in transmitter efficiency, an increase in ground receiver sensitivity, or an increase in ground antenna aperture.

• **Three networks now**—The U.S. is using three general-purpose satellite control networks that operate more or less independently—NASA's Minitrack system, the NASA *Mercury*-tracking network, and the Air Force satellite-tracking network. There are some other special purpose nets such as that used for *Transit*.

With more space vehicles operating simultaneously, each network will soon have to schedule its services more efficiently. A station's operational schedule must provide checkout and maintenance time without conflict with operational time. A priority must be established for simultaneously arriving space vehicles if both cannot be serviced at the same time. Stations of the near future must be able to switch rapidly from one satellite to another.

A central coordinating agency for all space flights similar to the FAA's service to air traffic, will soon be needed. As now conceived, such an agency would act as a central clearing house for all launch schedules and re-entry missions.

Cooperation between all the normally independent networks could be arranged to support a special mission requiring an unusual amount of tracking, command or data collection. Cooperation of all networks could also be directed toward an all-out search for a "lost" space vehicle.

A central agency would serve as an information collection and dissemination point for vehicle performance data, failure reports and future schedules.

• **Automation**—Future tracking and control systems may provide a significant change in tracking-station philosophy. Scattered throughout the world, the stations will most probably be completely automated.

Only a few trained personnel will be in attendance for maintenance and to handle emergency operational procedures in event of a major system failure. Display and control functions and all decision making will be conducted at a central data control center.

Digital computers at tracking sites and tied to a central computer will automatically handle all the necessary tracking, control and telemetry. Telemetry data will be monitored automatically and discarded unless measured parameters deviate from prescribed limits. Computers will automatically perform checkout and calibration procedures, with on-site displays used principally to alert personnel when something is abnormal.

• **Standardization** — Still another area for future development is establishment of a system of standards for tracking and control of space vehicles. Reliable satellite control equipment will require two areas of primary development effort.

First, the total number of series circuit elements in a system must be reduced in order to reduce the statistical occurrence of routine failures. This will require development of a test history on standardized circuits so that significant numbers can be inserted into statistical predictions.

Before this, however, must come a definitive listing of functions to be performed, plus accepted ways of providing these functions and a designation of circuits standardized for this purpose. Ultimately, a standardization of circuitry elements equivalent to that undertaken during World War II by the joint Army/Navy standardization program will be involved.

Long-term system planning is a major element in solving the problem. Despite a rapid advance in technology, a satellite tracking and control facility simply cannot become obsolete in a few years, since 22 years of total test time without a failure is required for space-borne equipment before one year of operating life can be assured with 90% confidence.

• **Radar**—Radar will continue as the principal data-collection system in aerospace electronics. Most of the current work is in heavy surface radar systems such as the DSIF, plus a lesser effort for radar in manned spacecraft and missiles.

No operational spaceborne radar systems now exist, but there is a heavy concentration of theoretical study on the subject and some hardware development work.

Radar hardware has kept pace with system performance requirements during the past decade, but the picture is changing. Today's complex system and variety of detection requirements have exceeded radar technology despite concentrated development programs by both government and industry.

Detection and tracking of "dark" satellites, detection and discrimination of a re-entering warhead, ultra-long-range radar systems for both atmospheric and space reconnaissance—all these present problems without tangible hardware solutions.

It is difficult to define the final path radar designers will take. But there must be a very careful evaluation of the trade-off between target detectability and signal resolution when selecting a wave form. Signal integration time is the key parameter in determining system complexity for a given modulation bandwidth.

With the determination of time-bandwidth, the remaining problem is one of extracting the desired intelligence from all targets available within the area of useful Doppler and range values.

• **Signal processing**—Signal processing includes signal gating, frequency filtering, analog storing and parameter estimation performed on reflected signals received over the effective integration time. Coherent techniques requiring matched filter or correlators are finding more general use for increasing efficiency.

Many design groups are re-evaluating the internal organization of various radar systems to find ways by which systems can make greater use of previously acquired information to seek out new, desired information. End result will be a form of self-organization and/or self-adaptive system.

• **Radar data processing** — The trend is toward digital data processing techniques in advanced, larger scale radar systems with the final step in the signal processing circuit being converted into digital code and operated on in a digital manner.

Existing digital data processing equipment seems fast enough for the job, since minimum sampling rates of most radar data processing applications are in milliseconds. Memory capacity and system operation speeds seem to be the upper limiting factor in determining the target handling capacity of digital systems.

• **Antennas** — The phased array is perhaps the most significant trend in radar development. Essentially a computer-programed combination of a number of separate receivers, transmitters and radiators, the array concept is leading designers toward new classes of radar equipment. Because total power output is the sum of the powers of individual transmitters, almost unlimited amounts of power can be radiated from phased-array antenna systems. Maximum power output is limited only by a voltage breakdown in the waveguide, the array face or the near-field.

The virtual elimination of mechanical problems with very large rotating dishes by phased-array systems may prove the array's scanning capability of greater value than its power handling. Because data rates are not limited by relatively slow mechanical response times, much higher scanning speeds become possible.

A phased array can provide extremely flexible scanning capability because areas of interest can be selected for scanning while others are excluded. Scan speeds are easily and instantly controllable with probability of multi-beam scan almost certain.

A computer-controlled system could be directed to areas of highest target probability, and could concentrate in this area. Side-lobe suppression, a major problem, can be controlled by regulating amplitude of the array elements.

Large scanning arrays can be built in convenient and economical form either on the ground or on the horizontal ground plane. This provides the advantages of minimum wind resistance and low profile.

Scanning arrays have been built in forms to cover part of a sphere, cylinder or cone. This approach will probably be carried further by designs for use on surfaces of missiles, aircraft and satellites. The system will probably be used with a computer to schedule necessary phase and current values for the various elements of a desired scanning sequence.

Use of electronic scanning on satellites will be particularly desirable because of the low energy required and because the lack of physical motion eliminates a tendency to disturb vehicle stability.

On the negative side are high cost, complexity and potential problems of element interaction and lack of element uniformity. A recent study estimated that a mass-produced active transmitter element operating in the 1.3-gc. area, with a 200-kw peak and 2-kw average power would cost about $5000. This would place 1000- to 5000-element full-scale array costs between $5 million and $25 million for the transmitter portion alone.

But plain garden-variety reflector-type antennas should not be overlooked. The large reflector antenna is now and will continue to be widely used for maintaining contact with space vehicles.

There is a definite need for reducing back-lobe radiation from the very-high-gain antennas. Once this is accomplished, space-vehicle tracking and control stations and other radio tracking services should be able to share the same frequency bands to a much greater extent than is now desirable.

Ground antennas will have narrow beam widths—on the order of one-half degree. The probability of the simultaneous appearance of two satellites in one antenna beam is relatively small. Many satellites, therefore, can use the same frequency without mutual interference.

Time multiplexing is accomplished by pointing an antenna at each satellite in turn and switching on the satellite transmitter via a command link. With two satellites in the same antenna beam, a difference in address codes will direct commands to the desired satellite.

Positioning a large antenna to a given point in space rapidly and accurately requires advanced development in antenna mounts and servo controls. The X-Y mount has been found more suitable than conventional azimuth-elevation mounts when used for satellite tracking. The X-Y mount avoids high angular rates on either axis when moving through high elevation angles.

The limitation of tracking is the "keyhole" angle measured from the zenith for the azimuth-elevation mount and from the horizon for the X-Y mount. The worst case is assumed where the satellite passes over the azimuth axis or over the X or Y axis.

Digital techniques have been developed and are now in use for pointing high-gain antennas. Shaft encoders with a resolution of 0.1 milliradian generate a digital signal which is compared, for each antenna axis, with a digital control signal. The difference signal is converted into an analog signal and used to actuate the antenna servo.

Low-noise devices such as masers, parametric amplifiers and low-power traveling-wave-tubes are being used at the receiving end of the systems to improve the signal-to-noise ratio. Error-correcting codes in some systems have led to data retrieval at S/N ratios of 30-40 db down.

The greatest percentage of today's electromagnetic communications operate in the High Frequency (HF) to C-band region with extensive development programs extending this range in both directions. Extension toward the lower frequencies is of greatest interest to the Bureau of Standards and various military organizations sponsoring a large amount of research in Low-Frequency (LF) and Very Low Frequency (VLF) areas. The Navy's *Lofti* satellite has been used in experiments to evaluate 18-kc signals transmitted from the ionosphere to Earth. Low frequencies may also provide an answer to penetration of the plasma sheath.

On the upper end of the frequency scale, the most significant developments have been in coherent infrared and light generation opened up by the maser and laser.

Design and construction of traveling-wave masers has permitted increases in gain bandwidth products to the order of 13 db with a 67-mc. bandwidth, tunable over a 359-mc. range with a pumping power of 100 mw. to 19 kmc.

An interesting developmental area in the maser field might lie in magnetically tunable masers. Theory indicates



*ELECTRONIC 'TREES' dot Stanford University's 'antenna farm' to receive radar echoes from Sun, Moon and other planets. The 48 log-periodic antennas are used to study interplanetary gases and matter. New 150-ft. radio telescope is in background.*

that if an optical ruby maser or similar device with a pulsed output well in excess of 100 watts is used, and if magnetic fields on the order of 100,000 gauss are imposed at liquid helium temperatures on crystal wafers of Germanium, the maser should be magnetically tunable in the far-infrared and sub-millimeter region of the electromagnetic spectrum.

In the next decade, masers should provide coherent monochromatic sources much more energetic and efficient than black-body radiation or harmonic generators now used. Low-temperature detectors using solid-state phenomena of superconductivity or maser amplifiers combined with coherent sources should make this energy-starved region a fruitful future developmental area.

Most laser research to date revolves around solid-state devices with the greatest interest being in development of higher power and longer operation. A number of solid-state CW lasers that operate in the milliwatt range have been announced. The kilojoule range in pulsed laser areas is rapidly being approached.

A ruby laser modulation system using a Kerr-cell shutter has been developed for application in harmonic generation, optical ranging and material research.

A great deal of R&D will be required before use of optical frequencies can be seriously considered for tracking and control of satellites. But the possibility exists and promises a large increase in available bandwidths, precision tracking capability, and security resulting from the very narrow "antenna" bandwidths with virtually no side-lobes of back radiation patterns.

Many experts feel that development of devices (and eventually systems) for the coherent light transmission might reduce the importance of the millimeter and sub-millimeter bands. The argument is that compared to coherent light their disadvantages far outweigh the advantages. An important fact, however, is that the millimeter waves behave similarly to circuits, being nothing more than an extension of microwaves, while coherent light demands an entirely new design approach.

Plasma sheath communications may require millimeter wavelengths. Theoreticians agree that frequencies above the plasma frequencies will enable sheath penetration. The plasma sheath depends upon many factors including the shape, speed and material of the reentry body plus the atmospheric density. Ablation products from the vehicle change the sheath's shape and plasma characteristics, greatly complicating the problem. ⌘

## Signal Generator



Model 412 FM Signal Generator, for check out of command receivers operating in the 400-550 mc band, features direct six-place digital readout of frequency. Accuracy to within 1 kc prevails at any setting throughout the frequency range. Continuous coverage is provided by a single tuning control. The unit is ideally suited for both frequency search and for setting to a given frequency, as well as receiver alignment, bandwidth testing, discriminator measurements, sensitivity measurements, filter attenuation measurements.

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## Power Oscillator

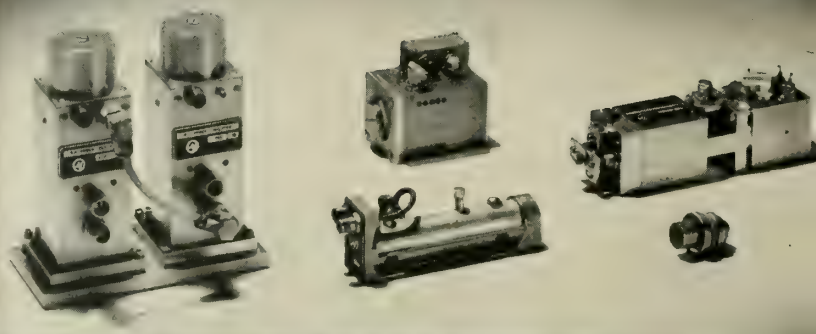


These precision units are designed for laboratory use in the evaluation of antennas, calibration power measuring devices, driving of amplifiers, and other applications where higher power ratings are required. Model 410, shown above, offers a frequency range of 500 to 1050 mc direct reading. Power range is 50 mw to 50 w. The unit measures 8″ x 11½″ x 19″ and weighs 45 pounds. Other models cover ranges from 200-550 mc. All components are conservatively rated and carefully arranged for long life and convenient inspection.

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## THE "VOICE" THAT CARRIED 22 MILLION MILES



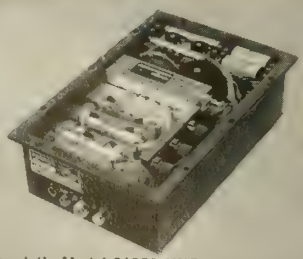
**Signals from a two-pound Microdot 150-watt Power Amplifier have been recorded from a solar satellite more than twenty-two million miles beyond the earth... another indication of the proven performance of Microdot rf cavities aboard satellites, ICBM's, and rocket sleds under the most demanding environmental conditions. Dozens of types are available off-the-shelf as standard miniaturized modules, or Microdot can supply cavities to meet customer specifications.**

**Microdot Power Amplifier Modules** are furnished as individual modules or designed into a complete Microdot transmitter, including power supply. Available with power output ranges from 10 to 150 watts and power gain of over 10 db, these units are used as power amplifiers and frequency multipliers.

**Microdot Frequency Multiplier Cavities** are standard modules assembled in a wide variety of combinations covering the entire frequency range from 100 mc to 3000 mc. Single cavities multiply as high as nine, have been cascaded for even higher multiplication, and will accommodate amplifiers to satisfy power requirements.

**Microdot Airborne VHF-UHF Transmitters** are complete, integrated systems built to meet your most exacting system requirements. They are comprised of standard Microdot miniaturized coaxial cavity modules (oscillators, amplifiers, and frequency multipliers), power triodes, pulsed oscillators and power amplifiers. Many modifications are possible to provide complete frequency coverage from 100 to 5000 mc.

For more information, write for these illustrated, detailed bulletins: Bulletin PTM-1, JSC-1, and ATC-1.



Microdot's Model 2406A UHF Telemetry Transmitter utilizes a unique, automatically stabilized circuit with the output frequency referenced directly to a quartz crystal, allowing greatly

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# Data Bottleneck Doomed by Changes

THE NEXT FIVE YEARS promise wholesale changes in space telemetry. Pressure is mounting on systems users and designers to break the data bottleneck which continues to grow with the U.S. space program.

The plea from industry for more government-funded R&D in this area may be answered shortly. NASA's FY '63 budget for electronic R&D includes a 60% increase over FY '62. Space agency officials, now putting together a broad 3-5 year electronics R&D plan, expect major annual increases for the next few years. DOD's research, development, test and evaluation budget may get an added boost due to mounting criticism of the limited U.S. military space mission.

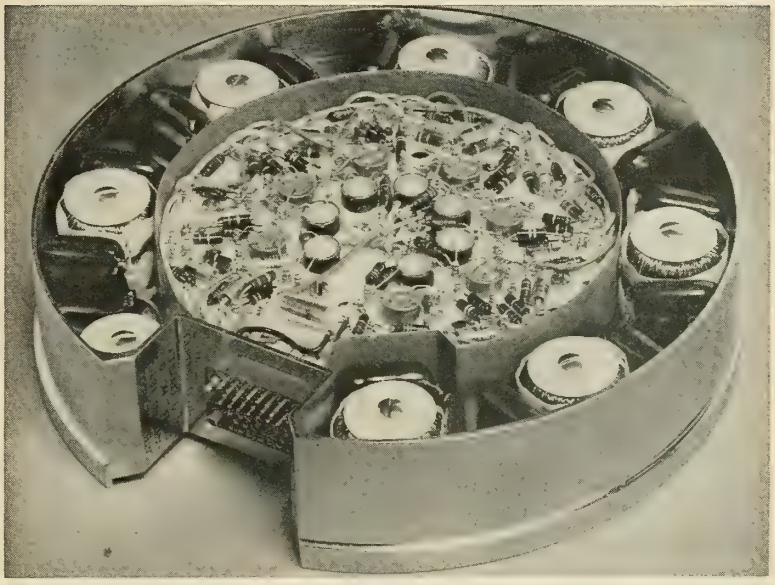
Telemetry seems to be on its way toward amalgamation into the broader field of telecommunications. As a result, emphasis and funds pumped into the rapidly expanding field of space communications (see page 46) are expected to produce much useful data—particularly in transmitter, receiver, and antenna development — for telemetry system designers.

• **Some results**—The net effect will be quicker development of several new components, techniques, and design philosophies, many of which have been in the wind for some time.

With respect to some of the long range programs, these include:

—Development of long-sought-after digital transducers with high resolution, accuracy, and speed. NASA officials believe devices of this type could be in use within a few years, erasing many of the system limitations now imposed by a-d converters. Some promising proposals are already in hand and under careful study. Fallout from guidance system development programs using pulsed components is also feeding the digital transducer effort.

—Development of a workable adaptive telemetry system. This is somewhat further off, though scientists foresee no theoretical bars. Such a system would probably be sensor-controlled with some ability to slow or speed data rates, manipulate bandwidths, introduce redundancy, change modulation schemes, or shift frequencies. NASA effort here is still in-house, but funds to go to industry with the problem are expected soon.



*SATELLITE DECODER developed by Avco Corp. for NASA vehicles. Design features special noise-immune filter that provides maximum security against channel operation due to random noise.*

—Combination of T/M, voice, tracking, command and possibly video into a single telecommunications link. The trend to telecommunications is widely considered to be inevitable. Problems center on bandwidth priority (especially with TV), accurate signal extraction and intermodulation effects. Eventually, this link will remove some of the major RFI problems which plague systems with numerous radiating sources.

• **Direction of present effort**—For the immediate future, the effort to take full advantage of available bandwidth, spectrum, and system capabilities will take the following predictable paths.

The trend to time-multiplexed PCM (pulse code modulation) digital transmission techniques is pronounced and will remain strong, though they may be combined with other modulation schemes to handle data variants with maximum bandwidth efficiency.

Government and industry will push for development of reliable solid-state circuits and components for use at 2.2-2.3 kmc microwave frequencies, to which T/M activity will eventually move in an effort to ease the crowded 225-260 mc band. Lack of such components has slowed the major move to these bands, now estimated for about 1970, though NASA says it will move its unmanned lunar and planetary probe T/M into this area probably within a year, using mostly traveling wave tubes and klystrons for final transmitter power output.

Extensive use of on-board data processing will come as a result of NASA and DOD pressure on designers and analyzers to reach more realistic data requirements. There is a great problem here, and all sources interviewed saw a challenge in this area as great as some of the technological needs.

Many government people believe familiarity with space parameters is reducing the reluctance of many engineers and scientists to part with information. One system envisioned by NASA would provide an on-board com-

# PCM TELEMETRY

**IDS conducts research and development programs and manufactures, under contract, transistorized/solid state systems and components in configurations tailored to military and NASA space requirements. ■ Example: IDS Model 3-12 transformer coupled commutator is believed to be the smallest for a 30 x 10 configuration available to the Free World. Designed for space requirements, the 3-12 is cased in a 3½" x 1½" x 2" enclosure and registers less than 0.25 μA back current at 85°C. ■ Instrumentation and telemetry capabilities are established in: ■ Commutators ■ Multiplexers ■ Programmers ■ A to D Converters ■ Signal Conditioners ■ Multicoders.**



Talk to IDS at Booth 84
National Symposium on Space Electronics and Telemetry
Fontainebleau Hotel, Miami Beach
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puter to look at all data, have them transmitted until a norm is established in operating parameters, and then become quiescent until variations in the norm occur.

Pre-detection recording equipment, capable of handling a wide range of T/M signals, will become more prevalent. With the advent of recorders with improved dynamic range, pre-D methods may eventually replace most post-detection systems.

Further refinements in miniaturization, now thought to be pushing state-of-the-art limitations, and development of reliable integrated microcircuity and components will be seen through order-of-magnitude improvements in transmitter power as a function of unit size and weight. No serious problems are envisioned for currently planned projects.

Development will accelerate on high-gain directional antennas and various wide-band antenna arrays for spacecraft, weighted carefully against a host of trade-offs in satellite attitude control, transmitter power, physical constraints, and size and weight limitations. Larger antennas will also cause field-of-view problems.

More efficient arrays will be developed, but for the time being parabolic devices will probably be used more extensively. Drag considerations will focus new attention on development of erectable antennas—pressure, mechanical, or self-erecting types. Spacecraft appendages such as solar-sails and nuclear-electric radiators may solve certain mounting problems.

Activity will increase, at least in the study phase, on use of the millimeter and sub-millimeter bands for telemetry and communications, partly due to their possible effective use as carriers in penetrating the plasma sheath during reentry and partly to increase the overall usable spectrum. Short wavelengths may offer military security and anti-jam capabilities. However, current inefficiencies in RF generating equipment, particularly at the sub-millimeter band, will have to be remedied.

Further reduction of receiver noise will continue to be pursued in lieu of substantially increasing transmitter demands, but some engineers believe study will shift from the front end to the IF and limiter portions, where frequency-compressive feedback and oscillator limiter techniques combine with pre-D recording to offer significant improvements.

Such low-noise devices as parametric amplifiers, tunnel diode amplifiers, and broad-band solid-state microwave amplifiers will come out of R&D into wider operational use.

Use of phase-lock loops will still be widespread, though long-range space use of the technique has some roadblocks in phase discriminator hardware. NASA reports it has study plans for other methods to improve receiver threshold.

• **Near-space antennas** — For near-space operation (to 60,000 miles), the trend in T/M receiving antennas will move toward wide-band multiple frequency dishes and away from more frequency-limited helical and yagi types. This will not erase the need for the latter types in some applications, particularly support of small scientific satellites.

For the manned lunar project, a string of 85-ft. dishes, possibly modified with Cassegrainian feeds plus a series of smaller-diameter dishes for the near-earth flight phase, will handle the requirements. For deep space, beyond the current 85-ft. diameters, NASA is developing a huge 210-ft. parabolic antenna at JPL. If another step is needed further down the line in long-range applications, NASA will probably go to group arrays of several dishes. Other inertialess scan arrays using dipoles, helical or yagi elements are being proposed for near space application. A universal polarization scheme, employing all modes and operator-selectable, is another antenna design goal.

Economic, logistic, and data acquisition back-up considerations will tend to consolidate ground sites. The trend will probably be noticeable with the advent of advanced weather and observatory satellites. A few closely tied wide-band data acquisition facilities, each with several antennas, are likely.

About 90% of space system failures being electronic in nature, according to NASA, reliability programs of the space agency and DOD will be stressed to a far greater degree than before, though both have somewhat different needs. NASA is now at work developing what it hopes will become a standard space-qualified parts list similar in use, but not in requirements, to military specifications. The market for radiation-proof components, says NASA, has never been better.

• **Modulation schemes**—If one area of T/M engineering can be said to be attracting the most attention, it would be modulation schemes. Within these methods, PCM is most often focused upon for space applications. Though PCM is "no panacea" for across-the-board aerospace telemetry, many believe it is likely to replace the older time-multiplex (PAM, PDM) systems for many applications.

With currently available encoders, PCM has an inherent data accuracy within 0.1%. It can handle a large number of channels over a single link, makes maximum use of natural digital outputs, is less sensitive to noise, samples data at speeds in excess of 50,000 bits/sec., has real-time and data-handling advantage at ground sites and in general

provides more flexibility and useful bandwidth than frequency-multiplexed systems for a given transmitter power.

Industry sources believe earlier, relatively fixed PCM formats will soon give way to more custom formats, including variable sampling rates and word lengths, for many long missions.

Despite PCM's latitude, the intense effort to optimize over-all system efficiency and performance for an entire space mission will lead to more combination techniques. This will prolong the life of some older schemes and give rise to some new ones.

FM/FM systems, for example, will continue to play a useful, reliable and economical role, perhaps enhanced by proposals to expand IRIG frequency range to at least 300 kc and possibly to 1 mc. Also, development of new frequency translation techniques may provide an increased number of channels with equal frequency response.

• **Saturn tested SS/FM** — Use of SS/FM to transmit wide-band vibration or acoustic data during checkout of large space boosters is also viewed favorably. The system was first used on the *Saturn SA-2* launching last April.

The SS/FM system with *Saturn* reportedly can handle 15 data channels, each with a response of 30-3000 cps at a bandwidth efficiency approaching 15%. This is roughly 10 times as efficient as FM/FM and about five times better than PCM/FM or PAM/FM.

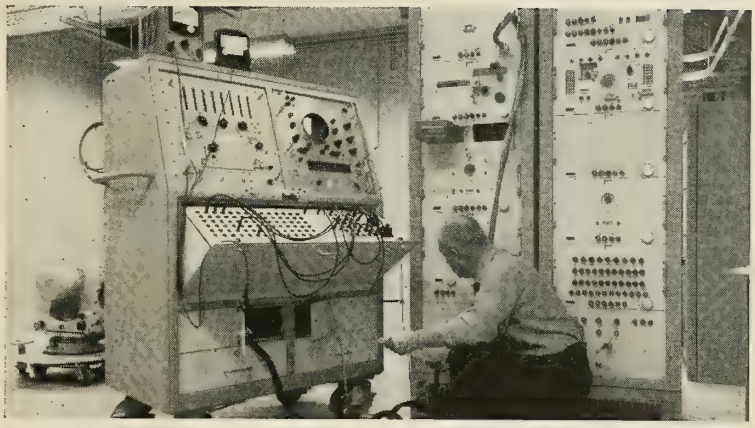
Engineers are also hopeful of the system's superiority in small satellites for PFM telemetry because of reported transmitter power efficiency as a function of bit rate. Such systems will be used in NASA's *S-3* energetic particles satellite project.

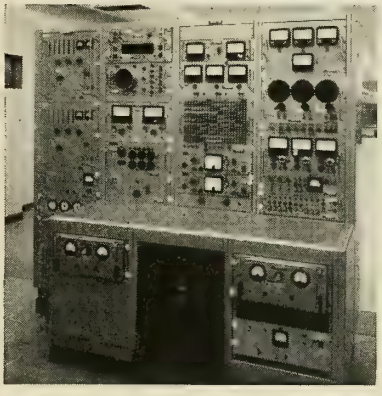
Biggest controversy in development of combined or hybrid modulation schemes as a means to an efficient "universal" telemetry package centers around the proposed combination of PCM and PAM.

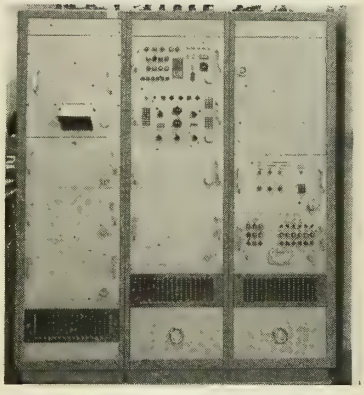
• **PACM system resisted** — A recommendation three years ago by Ford's Aeronutronic Div. that a PACM system —combining a high-accuracy digital PCM system with a lower-accuracy but high-data-rate analog PAM system— might offer the best solution has met with considerable challenge from other industry quarters.

Some of the major criticisms, however, were directed at use of the technique in missile technology. In spacecraft, overall efficiency of such a system is less controversial. DOD followed up the study with an award to Aeronutronic for prototype hardware, adding to hard feelings among others in industry. First flight test of this equipment may take place this month. ⌗

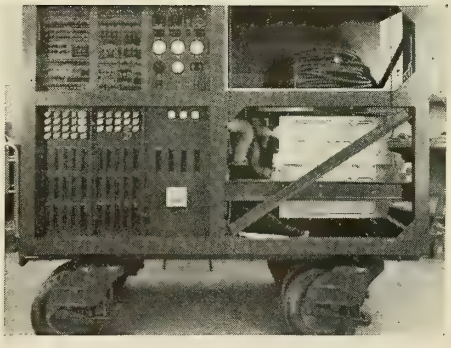

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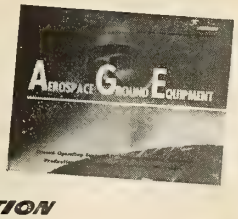
**ARMA'S experience in Aerospace Ground Equipment**



ARMA—creator of the Atlas inertial guidance system—has engineered and produced almost $2 billion of complex systems and components over the past four decades. This performance-proved ability is now available to aerospace contractors for the production and development of a wide range of systems and components in the areas of electronics, computers, inertial components, servomechanics and hydraulics. It includes:

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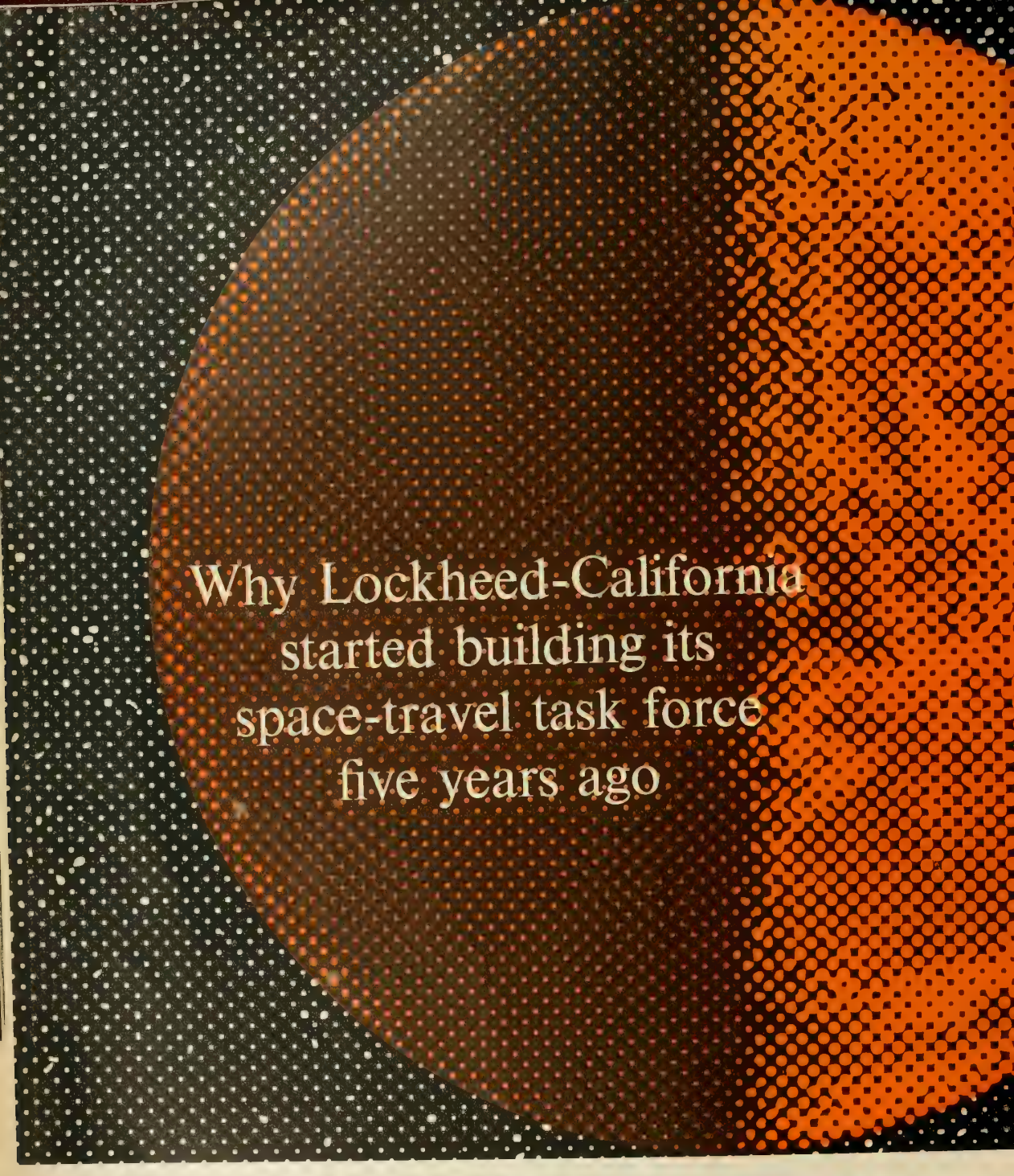
Complete details on production facilities and services are contained in booklet AGE-1. Write Corporate Government Marketing, Arma Division, American Bosch Arma Corporation, Garden City, New York. 8798




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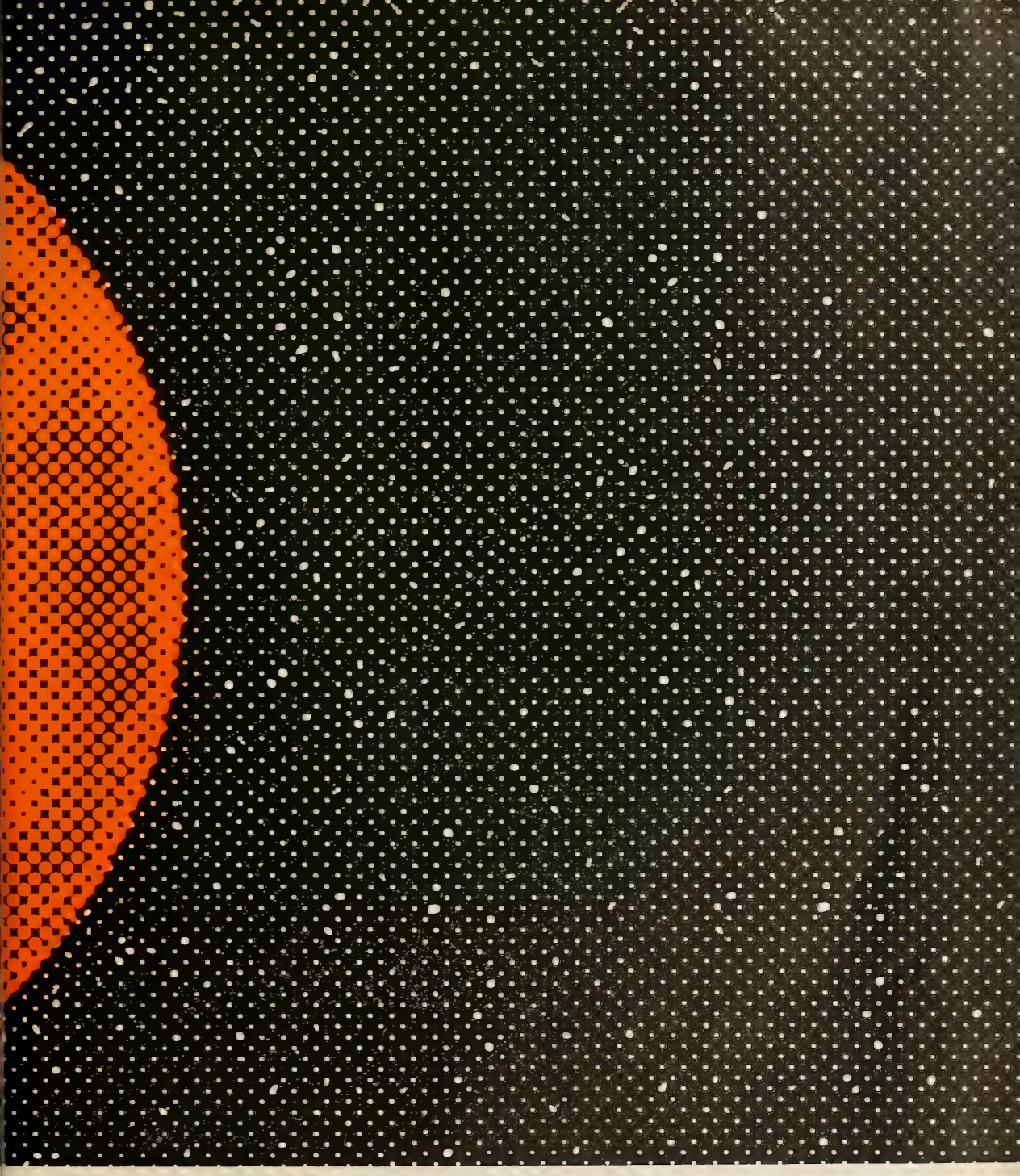
# Why Lockheed-California started building its space-travel task force five years ago

Back when satellites started making the headlines, it was clear that *man* in space was *next*—and that it would take a lot of groundwork to develop the capability to put them there.

That's why five years ago Lockheed-California anticipated this need and formed its SpaceCraft Organization—the group that has grown into one of today's specialized and knowledgeable man-in-space task forces.

From the beginning, the Lockheed-California SpaceCraft Organization has devoted its efforts specifically to the problems of transporting *men* from one point to another in space. This called for capability in almost every phase of space technology—solar physics, geophysics, astrophysics, biophysics, and radiation hazards—as well as the development of space vehicles and manufacturing techniques.

Today, the Lockheed-California SpaceCraft Organization stands 875-strong—experienced and ready to undertake important projects of the man-in-space age. This group has already made significant contributions to space-



craft technology such as the original Space Ferry concept, SLOMAR/SMART projects, and other major orbital vehicle concepts. Unique man-in-space manufacturing techniques of the Lockheed-California SpaceCraft Organization include the development of high-strength, lightweight, radiation-cooled spacecraft structures.

For more informationn about the Lockheed-California SpaceCraft Organization, write Mr. Robert A. Bailey, Lockheed-California Company, Burbank, California.

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# No Breakthroughs for Next 5 to 7 Years

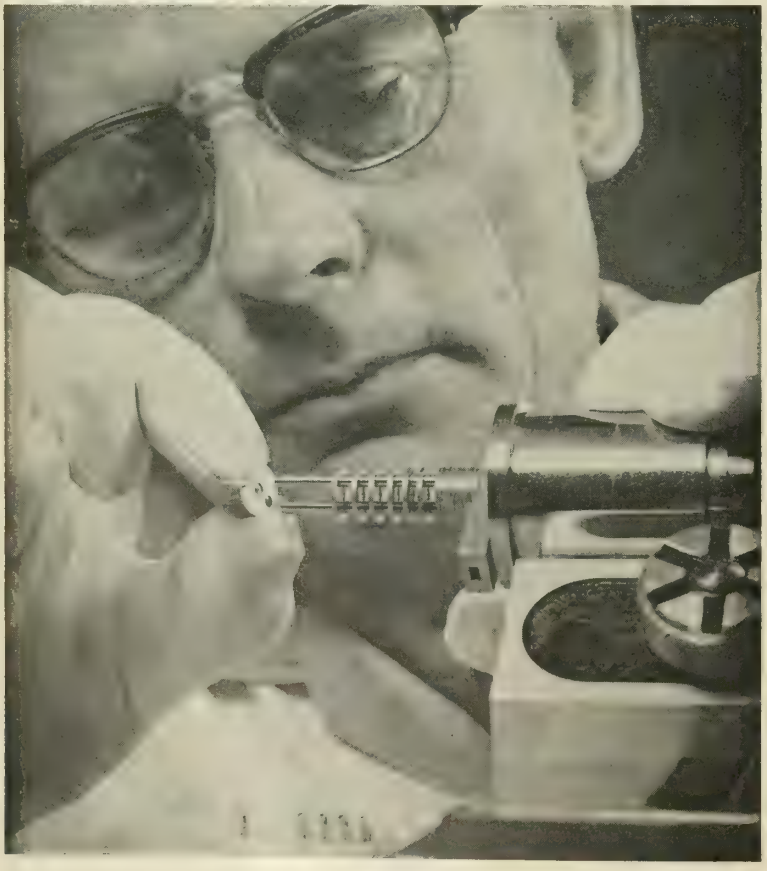
## *U.S. space program will be met through orderly advancement of communications art; optical frequencies hold promise*

COMMUNICATIONS REQUIREMENTS during the next 5-7 years of the U.S. space program will be met through orderly, incremental advances in the current state-of-the-communications-art. Very few, if any, breakthroughs are predicted, with the possible exception of progress in the use of optical frequencies exceeding the pace now envisioned.

Most observers believe that communications to the edge of man's solar system can be accomplished through sound engineering principles applied to existing or soon-to-be-at-hand technologies. Intergalactic communications, on the other hand, are admittedly beyond reach and are likely to remain so for quite some time due to the totally new problems posed by relativistic shifts.

Space communications needs for current projects are not all in the clear. There are still many problems to be solved in both ground and spaceborne equipment. Though much of the hardware to make these improvements is not yet on hand, many of the techniques are.

*HUGHES AIRCRAFT CO. technician assembles part of a new high-power amplifier tube which could eliminate re-entry radio blackouts experienced by astronauts.*



• **Noise reduction progress** — Significant progress has been made recently in reduction of overall receiver system noise, extension of solid-state componentry into higher frequency ranges, and reliability and performance of high power amplifier tubes. Given some fresh impetus by increased NASA and DOD funding, and a continued rise in company-funded R&D, temperature and noise levels should be pushed down even farther, and power and operating frequency levels should be raised even higher in the very near future.

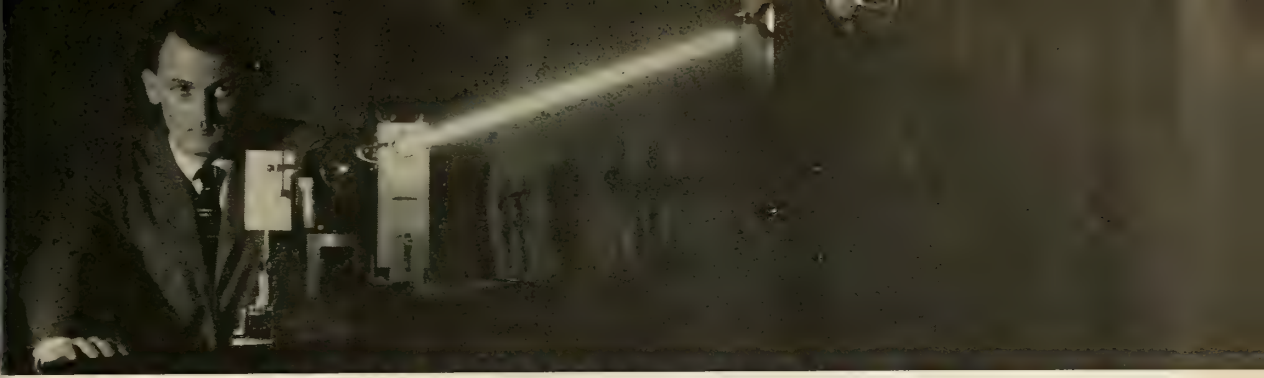
Reliability remains the chief bugaboo of space communications, be it communication satellites, scientific satellites, or lunar and interplanetary probes. Designers are becoming scrupulously conservative in their choice of components and systems. There aren't enough life data on some of the newer and more promising developments to warrant their use in a multi-million dollar vehicle traveling through a still-uncertain environment with no maintenance man aboard.

Data are just beginning to trickle in on the effects of radiation and various forms of shielding on semi-conductor devices. Most of this is coming from *Telstar*. More will come from the soon-to-be-launched NASA-RCA *Relay* ComSat.

Conservatism is obvious not only in component selection but also in total system design. The most recent example is *Telstar*, a remarkable success whose design is advanced in that it reflects not the very latest possibilities but the spoils of selectivity. "Where the art is uncertain," says Bell Telephone Laboratories' Dr. John Pierce, "we must start simple."

• **Telstar, Advent effects**—In fact two events of recent months — the amazing success of *Telstar* and the equally colossal multi-million dollar flop of *Advent*—are apt to shape the thoughts of space communicators for quite some time.

Though some hindsight may be claimed, there were many top space



*OPENING BY LASERS of the 300,000 kmc. bandwidth in the visible spectrum is one of most glamorous developments in space communications. Bell Telephone Laboratories technician here checks alignment of gaseous laser.*

experts who felt *Advent* was doomed from the start—greatly overdesigned, overweight, and overly ambitious in an area about which relatively little was known. It was recently disclosed that at least $75 million of the $170 million spent on *Advent* prior to its "reorientation" is a total loss. Hopefully, this won't happen again.

The frequency with which space probes, scientific and observatory satellites, and communications satellites are being launched has already begun to increase. Within the next few years, many of these programs will hit peak launch periods. To ensure reliable data links with these vehicles, the assault on improved space communications will be pushed hard from all directions.

On the ground, predictions of reductions in internal receiver noise and antenna temperature indicate that overall receiver system sensitivities by 1970 will be four or five times greater than at present.

R&D will continue at a high level on the use of cooled, low-noise parametric amplifiers, where engineers say still more decibels can be squeezed out. The use of extremely low-noise masers will also become widespread and will be responsible for the greatest reduction in internal receiver noise levels.

• **Equipment simplicity needed**— Louis Pollack, director of ITT's space communications laboratory, points out the need for development of more easily manageable and less cumbersome maser and cryogenic equipment, requiring little continuous high-level maintenance, for use in the string of smaller mobile ground stations certain to spring up around the world with the advent of global satellite communications.

The masers, coupled with new small RF components that can be mounted directly on the antenna to cut down on waveguide and rotary joint losses, will be vital to adequate reception by the smaller terminals.

With additional effort in the use of feedback techniques and solution of lingering phase response and time delay problems, engineers estimate overall improvements of 6-8 db are possible in detection and front-end systems.

As an example of progress being made in reducing antenna temperatures, JPL's 85-ft.-dia. Goldstone antenna, which operated at a temperature of 1430°K last year, will reportedly function at about 260°K with the addition of receiver parametric circuity.

By 1964, operating in the 2300 mc band and with the addition of a maser amplifier, low-noise Cassegrainian feed, and matching polarization, system temperature is expected to reach about 30°K. This figure probably represents realistic state-of-the-art limitations for the near future.

• **Antenna market expands** — The market for ground antennas to support the expanding observatory-type satellite, deep space, man-in-space, and ComSat programs shows signs of becoming extremely large. Dishes of 30-, 40-, 60-, and 85-ft. dia will be needed.

Performance of new dishes with greater than 200-ft. diameters planned for JPL may determine if there will be an attempt to go beyond the 85- to 100-ft. diameters which now seem to be the largest destined for any widespread space communications use. For the large moveable dishes, additional funds will be spent on improved mechanical design, servos and mounts.

NASA can be expected to augment the three existing DSIF stations with back-up 85-ft. dishes, positioned along the same longitudinal but not necessarily at the same site. Other dishes of this size will probably be built in the Far East, though political and geographic considerations are a problem.

Others to support meteorological satellite projects will go into Alaska and Eastern Canada. The market for smaller dishes in support of the observatory satellite program and as tie-ins to a global ComSat net is potentially tremendous.

There is some controversy concerning the place of the huge reflector-horn antenna used at the Andover, Me., *Telstar* terminal. According to some system planners, while the horn has operated extremely well and at exceptionally low-noise levels, in terms of "bits per buck" it is not likely to cause wholesale displacement of smaller and less expensive parabolic terminals. Some of these, when modified with Cassegrainian feeds and masers, will reportedly approach the horn in noise-level performance.

Additional research is also being performed on improved Cassegrainian feeds.

• **Design requirements** — Antenna design for lunar and planetary probes will require large-aperture antennas. The same is true for the wide information bandwidths expected to flow from observatory satellites and ComSats. Practical system gain limitations for single large dishes is reportedly about 60 db. However, gains of this level are certain to impose pointing problems due to the extremely narrow accompanying beam width.

Additional attention will be focused on reducing side and back transmission lobes as protection against unwanted solar, atmospheric, and earth blackbody radiation. The latter constraint may become especially important when communicating with low-altitude satellites whose tracks pass close to the horizon.

Along this line, the search will continue for geographic locations which can offer additional db simply by virtue of natural terrain shielding. Also considered must be remoteness from other RF sources (moving to higher frequencies will help here), yet the sites must be logistically accessible. For ComSats, a microwave plug-in should be reasonably near.

The Goldstone location is said to offer some 20-30 db in terrain shielding. There is not a great number of these sites available which may indicate some use could come from the now defunct Sugar Grove, W. Va. 600-ft. dish site.

*(Continued on page 70)*

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# Radio-Inertial Guidance Systems Preferred

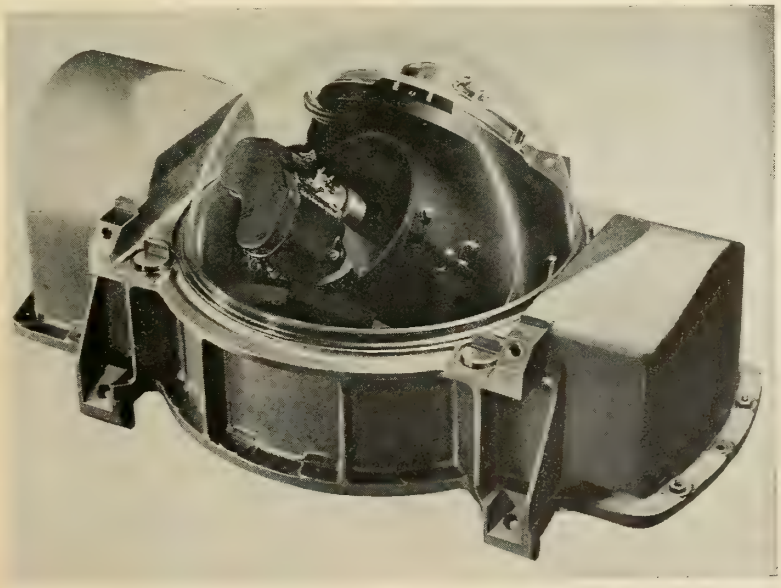
***Hybrid optical and radio/stellar inertial systems will dominate for later, long-duration manned flights; future inertial designs expected to be primarily digital***

RADIO-INERTIAL guidance techniques appear to have a distinct edge over pure inertial or even stellar-inertial approaches for space guidance and navigation for the next few years.

This is contrary to trends in missile systems, where the controlling factor has been security rather than accuracy.

At the same time, many in industry predict that in the next decade inertial systems will be further refined to offer even greater reliability and smaller size, and will be supported by better sensors. Some expect future inertial systems to be primarily digital.

• **G&C today**—As the technology stands today, radio guidance seems best for the majority of space missions currently planned. Radio inertial systems are predominant, and hybrid optical-/radio-/stellar-inertial systems for manned flight will dominate for later long-duration missions.



*KOLLSMAN Instrument Corp.'s KS-137 star tracker designed for NASA's Orbital Astronomical Observatory, being built by Grumman Aircraft Engineering Corp.*

Most long-range missions involve some form of mid-course correction. *Surveyor* will be the first deep-space vehicle to attempt a soft landing. This will require a highly accurate terminal guidance capability. The *Orbiting Astronomical Observatory* will require an extremely high-accuracy stabilization system.

Guidance technology required during the latter half of this decade will be derived from the techniques and hardware of these early systems and the experience gained through *Gemini* and the initial *Apollo* flight test.

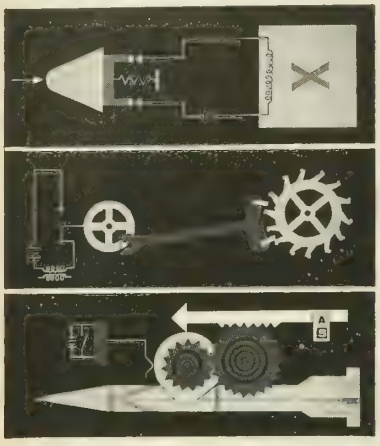
Concurrently, the *X-15* is serving as a flight test bed for both aerodynamic and outer atmosphere control mechanisms and systems. The adaptive control system in *X-15* will be the forerunner of that used in *X-20* and later maneuverable systems.

It is doubtful, however, that anyone can predict today with reasonable accuracy the guidance and control configuration in the advanced *Apollo*. A major advance in booster technology or a breakthrough in gyro devices could completely alter systems beyond 1966.

• **Theoretical breakthrough?** — Along with component advancements, step advances are needed in many areas, especially space navigation. Small mathematical study projects now being funded throughout the country by both NASA and the Air Force may bring gains in G&C techniques.

For example, the USAF Aeronauti-

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cal Systems Div. has continually sought to reduce the immense computational task associated with space guidance. Adaptronics, Inc., a small but well-staffed firm in Annandale, Va., was selected to concentrate on classical mathematical theorems and "look for a loophole in the existing calculus."

R. L. Barrons, the firm's chief engineer, told M/R that his group is convinced they have found such a loophole. Barron reported development of a mathematical basis for real-time computation of guidance-control maneuvers of the two-point boundary-value type.

The next step, he said, is to hold a feasibility demonstration. If the theory proves sound, the awesome complexity of path-to-go calculations will have been reduced significantly.

Current simulation results, stressed Barron, show that system terminal-error levels will be no greater than sensor threshold. Further, system response is devoid of limit cycles and does not overshoot. Unscheduled parameter changes —within the 10:1 or 20:1 range—produce no adverse effects, Barron reports.

• **R&D trends during decade**—Existing types of inertial guidance systems will not change radically over the next 10 years, according to Bernard Lichtenstein, guidance expert in General Precision, Inc.'s systems division. He believes this will prove to be a period of "consolidation and refinement," in which digital systems will predominate and some gains in reliability, size, and sensor accuracy will be made.

He also foresees greater use of gimballess platforms, and of stellar devices as auxiliary reference for inertial systems. He does not discount the possibility of some future use of lasers in a new family of navigational aids.

There is still much to be learned about space navigation, according to J. C. Records, general manager of GE's *Apollo* program; however, present radio-inertial guidance hardware and techniques are adequate for manned space missions in the near future, he says.

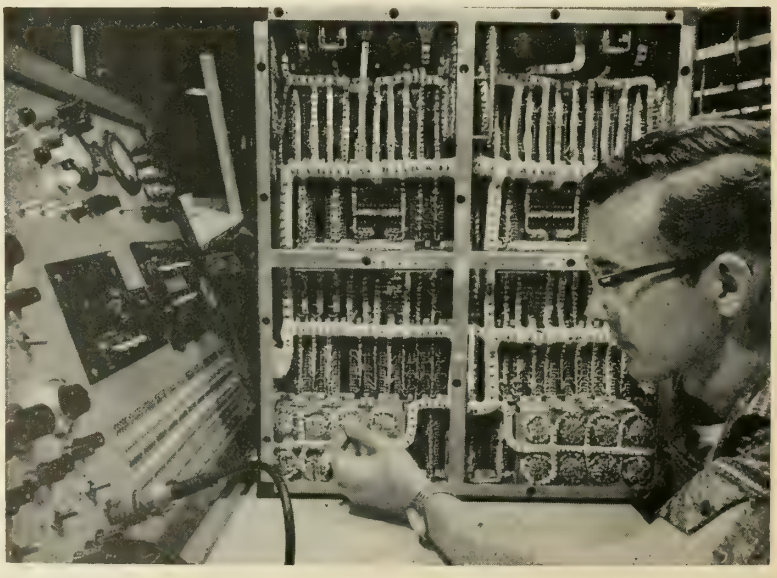
Engineers at Minneapolis-Honeywell expect increased use of inertial systems and a steadily growing use of auxiliary electro-optical inputs in space navigation —particularly for mid-course and terminal corrections.

In general, the experts predict that gas-bearing gyros will continue for some time to be the workhorses in inertial subsystems—because of their reliability, not their accuracy.

Opinions differ as to the future use of electrostatic and cryogenic gyros. Lichtenstein, for example, sees only limited use for such devices. Typical of the opposition are GE and Honeywell, both leaders in the development of such instruments.

Robert Hardesty, manager of advanced guidance and navigation at GE-Pittsfield, says that while electrostatic-gyro use is closer, cryogenic systems will take a firm hold in 5-10 years.

A problem with the cryogenic is that it requires elaborate cooling. But, said Hardesty, there are distinct advantages in a navigation system entirely designed for cryogenic operation. He predicted that before 1970 such a system would be completed occupying roughly half the space of a standard desk. The complete



*SELF-ADAPTIVE flight-control system now flying in No. 3 X-15 gets final check at Minneapolis-Honeywell's Aeronautical Div. Computer contains nearly 9,000 parts.*


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system, he said, will require almost negligible power. The only power leads would extend from the closed package and optical readout will be used.

• **Some limitations**—A problem inherent in the entire space field is customizing subsystems for specific missions, particularly guidance and control systems. Because of this, standardization is rare.

Some engineers say that if anything can be standardized it might be the G&C computers—at least to the extent of standardized families with interchangeable subsystems.

Another long-term problem involves G&C systems design. Such systems require complete component and circuit integration. The variety of technologies and complex work involved call for many specialists to perform the complete design task.

To ease the design problem, G&C manufacturers are relying more and more on computer optimization techniques that permit rapid and reliable error analysis.

Another major technical limitation is found in the manufacture of precision gyros. Many engineers predict an approaching barrier to further error percentage reduction in inertial units. A breakthrough is needed to permit a significant gain in accuracy. The nuclear-spin gyro could be the next major development. Use of superconductive shields may help in permitting uncluttered measurement of magnetic moments.

• **Booster control trends**—In a recent paper entitled "Satellite Booster Control," A. F. Schmitt of General Dynamics/Astronautics, San Diego, traces the technological growth of guidance and control in boosters during the 1960's. The following points summarize Schmitt's conclusions concerning future trends in this vital field:

—Satellite-booster flight-control systems will use closely integrated autopilot guidance functions. For increased efficiency, digital computers will find increased data processing tasks to provide both short period mode stability and mission guidance.

—Self-adaptive control systems—needed for short-period modes—must provide stability and acceptable response under conditions of wide vehicle-parameter variations. Under such severe conditions, adaptive flight-path guidance could provide maximum performance in the presence of physical constraints.

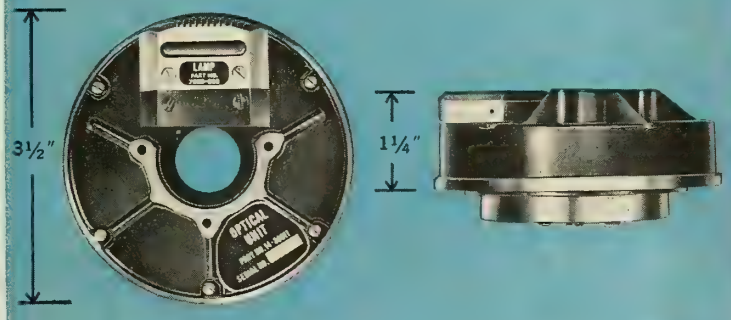
—Maximum systems reliability, considering the very high costs of next-generation boosters, may warrant judiciously employed subsystem and component redundancy. ⁂


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**A Message to the Engineer/Scientist Community At Large — and a Question:** there's a dynamic technological race going on at the Atlantic Missile Range, a race between the fast-increasing capabilities of new missiles and space vehicles and the capacity of range instrumentation to test their performance. ☐ We wonder how much you have heard about this. . . . and about the challenge it offers engineers and scientists with PAN AM at Cape Canaveral? ☐ You may know a small segment of the work . . . many do. But only a handful are aware of its scope. In fact, we of PAN AM'S Guided Missiles Range Division sometimes think that only the ubiquitous seagulls know the full story of the new range instrumentation technology we've created in the 9 years we've been charged with development and management responsibilities for AMR by the U.S. Air Force. ☐ The measure of the distance we've come is the measure of the technological jump between MATADOR and MARINER. ☐ In the simplest terms, this has meant acquiring ever greater funds of data, of ever higher accuracy, at ever greater distances — and converting and transmitting it at ever increasing speeds. ☐ FIRST, the existing range instrumentation and communications techniques were pushed to the utmost bounds of their capacities — THEN they were replaced with new range systems built to new concepts, as specified by PAN AM engineers and scientists backed by research groups. ☐ *Today — a new phase of range technology development is under way — staff build-up is proceeding on schedule.* ☐ To meet the demanding requirements of both today and tomorrow, much of the work of the Range is divided into three time projections:

**(A)** designing and implementing range instrumentation for launches programmed for this year and next;

**(B)** developing range technology concepts required for launches in the near future (Dyna-Soar, Gemini, Apollo test vehicles, advanced Saturn boosters and Nova);




**(C)** advanced planning, looking forward as much as 15 years. Includes considering such problems as how to service, launch, track and recover information from multi-million pound thrust booster systems and anticipating the problems associated with the launching and support of nuclear propelled boosters and spacecraft.

**OPPORTUNITIES are open right now to join Pan Am in developing range test systems of hemispheric, global and celestial scope.** ☐ ☐ **SYSTEMS ENGINEERS** EE, Physicist — capable of accepting project responsibility for design of range instrumentation systems, monitoring systems development, installation and acceptance. (Must also be adept at liaison.) Background in one of the following areas is essential: Pulse radar, CW techniques, telemetry, infrared, data handling, communications, closed circuit TV, frequency analysis, command control, command guidance, underwater sound, timing ☐ **INSTRUMENTATION PLANNING ENGINEERS** EE, Physicist — with managerial capacities, to accept responsibility for specific global range instrumentation concepts. Must be able to comprehend overall range instrumentation concepts and have extensive experience in one of the following areas: radar, telemetry, infrared, optics, data handling, communications, underwater sound, shipboard instrumentation ☐ **SENIOR ENGINEERS & SCIENTISTS / FORWARD PLANNING** PhD's, Math., Physics, Applied Mechanics, Astronomy, Electronics — to evaluate and project the state-of-the-art in all applications to range instrumentation. Help establish both theoretical and practical limitations of existing relevant technologies. ☐ **In addition to** all the uncommon professional values, you get Florida, too! Those who enjoy casual, year-round, outdoor living are in their element at the Cape, where a majority of engineers and scientists live and play near the water. Consider too that PAN AM gives you a 90% world-wide air travel discount.

Why not write us today, describing your interests and qualifications in any of the areas above. Address Dr. Charles Carroll, Pan American World Airways, Inc., P. O. Box 4336, Patrick Air Force Base, Fla. An Equal Opportunity Employer.

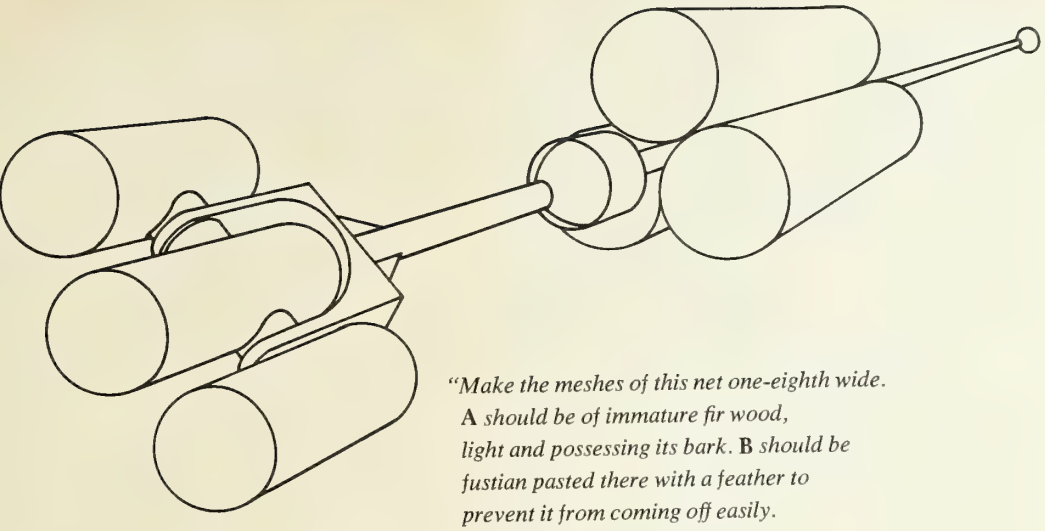
PAN AM

**GUIDED MISSILES RANGE DIVISION**

**PATRICK AIR FORCE BASE, FLORIDA**

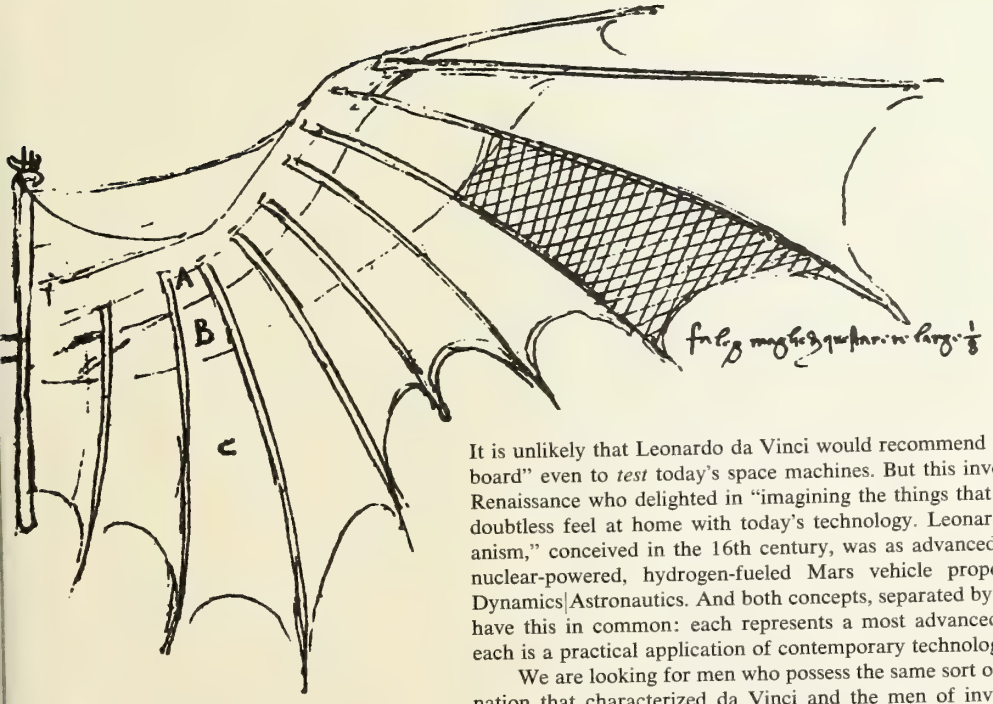


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*"Make the meshes of this net one-eighth wide.*
*A should be of immature fir wood,*
*light and possessing its bark. B should be*
*fustian pasted there with a feather to*
*prevent it from coming off easily.*
*C should be starched taffeta . . .*

**and as a test, use thin pasteboard."**




It is unlikely that Leonardo da Vinci would recommend using "thin pasteboard" even to *test* today's space machines. But this inventor-artist of the Renaissance who delighted in "imagining the things that are to be" would doubtless feel at home with today's technology. Leonardo's "wing mechanism," conceived in the 16th century, was as advanced in its day as the nuclear-powered, hydrogen-fueled Mars vehicle proposed by General Dynamics|Astronautics. And both concepts, separated by centuries of time, have this in common: each represents a most advanced state of the art; each is a practical application of contemporary technology.

We are looking for men who possess the same sort of unbridled imagination that characterized da Vinci and the men of inventive vision who followed him. The kind of men, in fact, now at Astronautics designing the space systems of the future — an iminent future measured not by centuries but by days and weeks.

If you are challenged by "imagining the things that are to be," learn more about General Dynamics|Astronautics and its role in space.

Use the convenient inquiry form attached, or write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Department 130-90, General Dynamics|Astronautics, 5765 Kearny Villa Road, San Diego 12, California.

GD

**GENERAL DYNAMICS | ASTRONAUTICS**

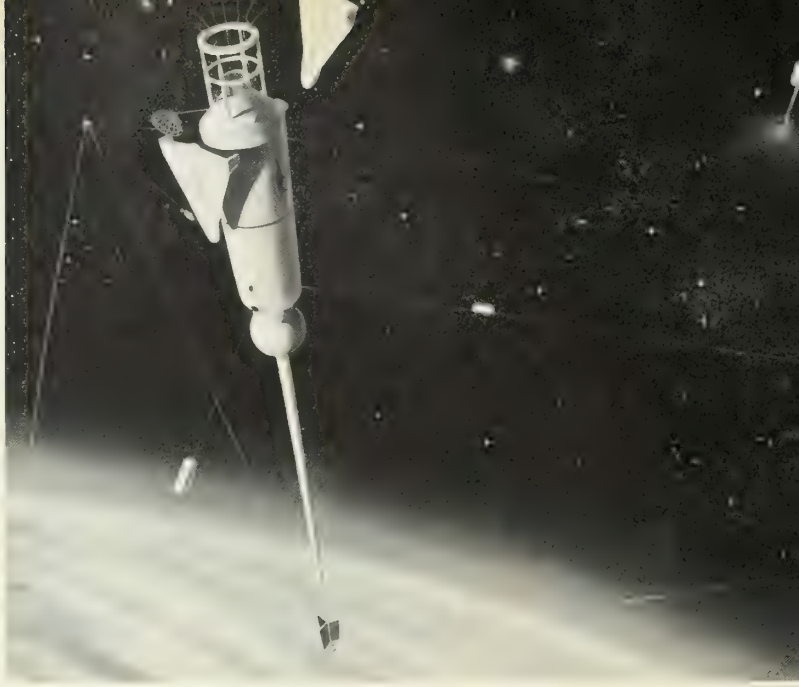
## ENGINEERS AND SCIENTISTS

Are you challenged by "imagining the things that are to be?" For example, this General Dynamics|Astronautics concept of a multi-purpose spacecraft, designated "Migrator." Beginning in 1968, it could serve as a highly versatile, operational space station.

"Migrator" will contain an onboard propulsion system, giving the vehicle the capability to migrate from one operational site to another, and will offer extended usefulness by serving as an interplanetary spacecraft.

At Astronautics, "imagining the things that are to be" is a technical and professional way of life. So is the practical application of that imagination to the space hardware of the future.

Current requirements are detailed below. If they meet your ambitions, and you would like to arrange a personal, confidential interview in your area, we invite your inquiry. It will be promptly acknowledged.



### DYNAMICS ENGINEERING

Positions exist in the following two areas:

STABILITY AND CONTROL — To conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamic behavior of space boosters.

STRUCTURAL DYNAMICS — To determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

A degree in engineering, physics, or mathematics, plus at least two years of experience in the application of analog and digital computer techniques required for positions in both areas.

### STRUCTURAL DESIGN

Positions involve the design of airborne structures, including fairings, fixtures, and basic missile body structures. A degree in AE or ME plus aircraft or missile structural design experience required.

### WEIGHTS ENGINEERING

Assignments involve working with predesign, design, and test functions to control system and vehicle weight and balance. A degree in engineering or physics, plus two years of experience in the establishment of system and component weight allowances and control, required.

### GUIDANCE ANALYSIS

Responsible for the development of families of equations for guidance of space boosters and simulation of vehicle and guidance system performance by application of digital computer techniques. A BS or MS in engineering or mathematics required.

### ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, nuclear-pro pelled space vehicles, earth-to-moon logistics bus, and spac stations. Experience should include advanced design work i such electronic areas as guidance, communications, telemetry data processing systems, antenna systems, or electronic groun support systems. An advanced degree is required.

### OPERATIONS AND SYSTEMS ANALYSIS

Projects involve the study and development of advanced ballisti missiles and boosters, plus both military and non-military orbit and space systems. Responsibilities include advanced system planning, conceptual design, and systems evaluation. Advance degree preferred; three years of appropriate experience require

### THERMODYNAMICS ENGINEERING

Responsibilities include development of design criteria and pe formance of methods development in the area of thermodynamic Particular emphasis is on re-entry heating, heat dissipation in fre space, and aerothermal heat sources. A degree in ME or AE an two years of experience required.

### FLIGHT MECHANICS

Positions are in a newly organized Flight Mechanics Developme Section. Programs include aerospace vehicle guidance and auto matic control, aeroelasticity, and aerophysics. Responsibilities the Section also involve technical analyses and simulation wor in support of all space vehicle programs at Astronautics. A alytically talented graduate engineers at all levels of academic ar professional achievement are required.

*To obtain full information about these and many other enginee ing and scientific opportunities at Astronautics, or to arrange confidential interview in your area, mail the attached Profession Placement Inquiry. If it has been removed, or if you wish furnish or request additional information, write to Mr. R. Smith, Chief of Professional Placement and Personnel, M Zone 130-90, General Dynamics|Astronautics, 5765 Kearny Vi Road, San Diego 12, California.*

GENERAL DYNAMICS | ASTRONAUTICS

**SPACE POWER**

# $215 Million in NASA Power Program

***Space agency will spend $115 million on nuclear power, $100 million on non-nuclear AR&T through 1970***

NASA WILL SPEND about $215 million through fiscal 1970 for space-power advanced research and technology—$115 million for nuclear and $100 million for non-nuclear work.

About 20% of the money will be spent in-house—the rest on outside contracts. None of this work will be related to particular vehicle projects.

The Air Force during the current fiscal year expects to spend more than $14 million for contracted applied research to develop concepts, components and systems for flight-vehicle power. This money does not include funding for line items. Last year's budget for contracted flight-vehicle R&D ran about $12 million.

Current NASA AR&T fiscal year funding is about $10 million; this figure is expected to increase over the next two or three years. Work on space power for particular projects such as *Gemini* and *Apollo* will in total consume considerably more money than for AR&T.

Performing and monitoring all the Air Force's applied research on flight-vehicle power is the Flight Vehicle Power Branch, Aeronautical System Div. (ASD), Wright-Patterson AFB. The systems getting the most emphasis are the 300-kw space-nuclear system *SPUR*, and the 15-kw solar-mechanical-engine *ASTEC*.

*SPUR* is currently running at about a $1-million annual effort, and *ASTEC* at $500,000. An Air Force source says that both efforts are due for increases.

• **Looking ahead** — NASA's programs in non-nuclear power are under the general direction of Walter C. Scott, chief of space power technology programs in the Office of Advanced Research and Technology. Technical direction of contracts in this area is the responsibility of personnel in several of NASA's field centers.

Nuclear-electric development work is under the direction of Dr. Fred Schulman at NASA headquarters.

Scott's observations about future space-power systems:

—The solar-power systems will remain predominant: they're clean, do not require packaged energy, and have no radiation hazard. They can provide long life.

—Solar cells will remain very important. Technological goals: improved radiation resistance, lower weight, lower cost, better mechanical properties, higher efficiency and improved temperature characteristics. Thin-film devices appear attractive in several of these categories.

—The future of dynamic power-conversion systems is hard to predict. There is a great deal of technology in this field which should be exploited in space, if possible. The peculiarities of the space environment, however, cause many problems which have not been adequately solved.

—Solar thermionics may be quite important. Some problems: development of very accurate, lightweight solar concentrators and efficient long-life diodes. Present technology in mirrors for high-temperature converters allow serious development of such systems for power levels of a few hundred watts or less such as NASA's SET (Solar Energy Thermionic) program. With the development of large launch vehicles, accurate one-piece mirrors 20 or 30 ft. in diameter may be attractive for larger systems.

—Use of radioisotopes probably will be limited to relatively low-power systems where long life is required or where very difficult environmental conditions such as extremes of temperature or radiation environment prevail.

—Nuclear reactor systems will come into their own wherever high power is needed, particularly for uses such as electrical propulsion.

• **Power requirements**—Most space probes during the present decade will need not more than 5 or 10 kilowatts, according to Scott. A few vehicles such as large manned orbiting laboratories may go above 5-kw to 15-30 kw, he said. Commercial communications satellites—when they are in operation—may also need higher power. He observed that these few vehicles are the only ones that may need high-kw power for purposes other than propulsion until the 70's.

For the manned vehicles, Scott sees the following contenders: fuel cells, chemical engines such as hydrogen-oxygen reciprocating engines, or expansion engines using waste heat, and solar.

"The chemical engines look pretty good for short duration flights—about 20-40 hours," he said, "Fuel cells look more attractive for lifetimes up to several weeks. Reason is that the weight advantage for the low equipment weight of the engine is quickly overcome by the lower fuel-weight penalty for fuel cells, due to their higher efficiency."

Nuclear reactor and solar systems are seen dominating the high-kw field.

Scott nevertheless believes that chemical power-conversion systems for manned flight may become the chief ones used at least into the early 70's.

• **Batteries improved**—Scott is calling for improved energy-storage devices—an echo of an ASD plea made to MISSILES AND ROCKETS earlier this year (M/R, March 26, p. 74).

For low-orbit satellites, NASA would like to get batteries with higher specific weights than the present useful 1-7 watt hours/lb.

For a relatively long life, Scott sees the nickel-cadmium battery as the best choice at present.

While less is known about it, the silver-cadium battery shows real promise for a mission of three to six months. The useful capacity per pound of the battery is higher than for nickel-cadmium but the ultimate life is not expected to be as great.

Although NASA has used some silver-cadmium batteries in space—*Explorer XIII*—additional development is needed before wide use can be expected.

A quantum step forward possibly could be taken by using battery systems of molten salts. ASD scientist James E. Cooper observed to M/R recently that

## Possible Space Power Systems For Large Manned Space Stations

| CONVERSION | SOURCE | | | |
|---|---|---|---|---|
| | SOLAR | NUCLEAR | | CHEMICAL |
| | | REACTOR | RADIOISOTOPE | |
| SOLAR CELL | | | | |
| THERMOCOUPLE | | | | |
| THERMIONIC | | | | |
| FLUID/MECHNICAL | | | | |
| FUEL CELL | | | | |

*(Color denotes combinations NASA considers most probable.)*

## Current Solar-Power Development Programs

| AGENCY | TITLE | TYPE | POWER KW | STATUS |
|---|---|---|---|---|
| —— | —— | SOLAR CELL | < .5 | STATE OF ART |
| NASA | SUNFLOWER | FLUID/MECHANICAL | 3 | TECHNOLOGY ONLY |
| NASA | SET [1] | THERMIONIC | 1.15 | 1964 (?) |
| USAF | —— | FLUID/MECHANICAL | 15 | TECHNOLOGY ONLY |
| USAF | STEPS [2] | THERMIONIC | 15 | TECHNOLOGY ONLY |
| USAF | —— | THERMOCOUPLE | 1.5 | TECHNOLOGY ONLY |

*1—Solar energy thermionic*
*2—Solar thermionic electrical power system*

## Current Nuclear-Power Development Programs

| AGENCY | TITLE | TYPE | POWER | FIRST FLIGHT |
|---|---|---|---|---|
| USAF/AEC | SNAP-2 | REACTOR FLUID/MECHANICAL | 3 KW | 1965 |
| NASA/AEC | SNAP-8 | REACTOR FLUID/MECHANICAL | 30-60 KW | 1966 |
| USAF/AEC | SNAP-10A | REACTOR FLUID/MECHANICAL | 500 W | 1963 |
| USAF/AEC | SPUR/SNAP-50 | REACTOR FLUID/MECHANICAL | 300 KW —1 MW | 1969 (?) |
| USAF/AEC | SNAP—ODD NUMBERS | RADIOISOTOPE THERMOCOUPLE | < 125 W | VARIABLE |

such batteries offer a potential greater than 500-watt-hours/lb.

• **Space station power** — Multi-manned space stations will use most of their auxiliary power for environmental control systems. Their power requirements dwarf all others except propulsion.

Although such stations will probably not be operational this decade, the systems design for them will be underway before 1970. For this reason, the Air Force and NASA have been studying the power needs. In this connection, North American Aviation, Inc., made a power analysis of a 38-man station 150-ft. in diameter. Total power needed on board, 11 kw; peak power needed, 20 kw.

Power breakdown: environmental control and lighting, 7.2 kw; stabilization and control, 0.4 kw; food preparation, 0.2 kw; communications, 0.8 kw; experiments, 2.4 kw. For a regenerative supply for oxygen when electrolysis is used, 12 kw more are needed.

The space-station power system proposed by NAA consists of seven solar-cell panels having a total area of 2325 sq. ft. Average power output, 11 kw; weight, excluding power storage and control, a little over 2500 lb. Power would be stored in nickel-cadmium batteries, 25 kw-hr capacity; total weight, about 2600 lb. Power control would weigh a little more than 315 lbs.

Thus the total system weight would be close to 500 lb./kw, considered a good tight design in today's technology.

With respect to the NAA study, NASA scientists John R. Dawson and Atwood R. Heath, Jr. made the following points:

—If a space-station power system with advantages going beyond those obtainable from solar cells and batteries is desired, a choice must be made between solar and nuclear energy sources.

—If an advanced solar system is selected, tailoring the actual power system probably will have to be part of the space-station development. The feasibility of advanced solar-power systems is part of NASA's continuing program, for example, SET and *SUNFLOWER*.

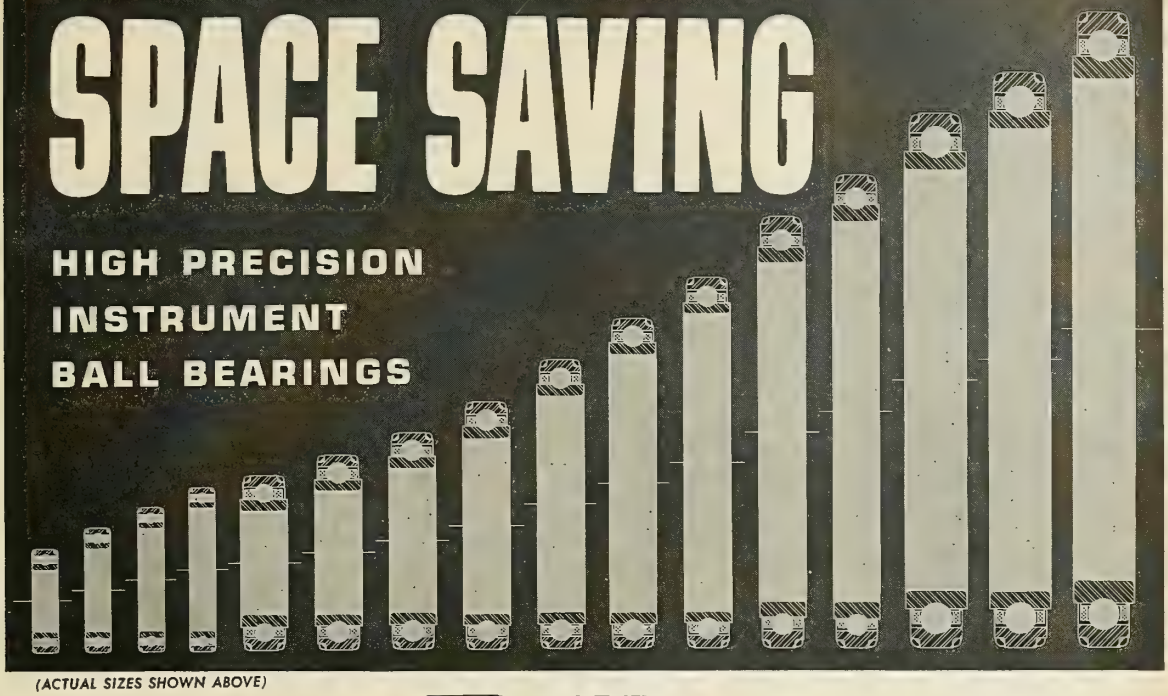
—The nuclear-power program is providing systems having capacities of interest for space stations; these systems should be available in the late 1960's.

Thus one thing is clear about space power plants for a large manned space station: they will not be off-the-shelf items but will have to be tailored to the vehicle—at least for the foreseeable future.

For smaller orbiters, particularly unmanned ones, pre-packaged space-power most likely will be the rule, particularly as time goes on. Flexibility will be in terms of stacking modules to gain increased power. ⁂

# SPACE SAVING

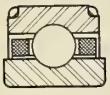
## HIGH PRECISION INSTRUMENT BALL BEARINGS



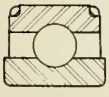
(ACTUAL SIZES SHOWN ABOVE)

- *SBB offers seven types of construction . . . in all 16 sizes from 3/8" to 3 1/16" bore.*
- *Three grades of high precision, corresponding generally to ABEC 3, ABEC 5, and ABEC 7.*
- *Special designs — DF or DB preloaded pairs with or without spacers — size coding.*
- *Standard availability in 440C stainless or 52100 steel . . . special materials to order.*

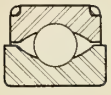




**TCR** patented SBB construction (without loading slots or counterbore) utilizes maximum ball complement with one-piece reinforced phenolic retainer, for maximum load capacity. Up to 62% greater load and 400% greater life potential than offered by conventional Conrad design. Also features low torque and high limiting speed values. Available with bronze retainer as type TCB, or stainless retainer, type TCS.



**TCF, TCA** patented SBB construction permits utilizing full ball complement without resorting to loading slots or counterbore; for heavy loads and relatively low speeds. Type TCA is same as Type TCF, except alternate balls are undersize to function as ball spacers; for moderate loads and speeds.



**TWF, TWA** patented SBB construction, internally similar to Types TCF and TCA, except rings employ unique integral shield design, which with close clearance annulus and grease lubrication functions virtually as seal. Type TWF with full ball complement, and Type TWA with alternate balls slightly undersize.



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**TKR** Conventional Conrad design with one-piece snap-type reinforced phenolic retainer — capacity less than type TCR patented SBB construction, but adequate for many instrument applications at lower cost. Also available with Teflon slug ball spacers as type TKL, or with spring separators as type TKP.

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# Demand for Repair Capability Growing

REQUIREMENTS for onboard test and maintenance are seen by many in industry as the cause for the most significant change expected in the field of electronic checkout systems in the next decade.

The introduction of man into the spacecraft systems loop creates a growing demand for a repair capability. Increased boost capability and the corresponding increased flexibility in mission diversity will determine the types and extent of onboard checkout systems.

The field is moving in two directions: universal automatic/semi-automatic hybrids (for equipment or vehicle families) and specialized checkout systems (as for *Apollo*). Also, systems may now be categorized as to ground-based or on-board.

Two new design trends are beginning to take shape: one incorporates the checkout or test feature into the operational equipment itself; the other involves a checkout system capable of being used for training operators when it is not performing its test function (the latter, built by Martin Co., is being evaluated by the military).

A dominant peculiarity of the leading manufacturers is the relatively few who concentrate in checkout. These include such companies as RCA, Northrop, Bendix, G.E., and Martin.

Most large primes tend to try to handle their checkout programs in-house—whether there is competence or not. Another twist is for some primes to hold large competitions for checkout subcontracts, obtain proposals from the experienced firms, then make the awards to unknown small business under their dominance.

• **How far to automate?**—The biggest question mark in this field, including ground checkout, is the degree of automation that will be required or even desired. The trend over the past 10 years has been toward more fully automatic testing of complex missile and space systems. But there has been a change in the past two years. Test instrument and checkout manufacturers have taken a closer look at requirements. The result has been an emphasis on making more effective use of the operator.

Robert Featherstone, acting general manager of General Electric's Defense Systems Department, told M/R he believes that operator judgment offers an extremely important contribution to checkout performance. The problem now faced by industy, he stressed, is how to get an optimum balance between manual and automatic operation. This is particularly true of ground-based systems, said Featherstone; however, he feels it may be that less equipment will be required than might be expected in manned spacecraft.

Others feel that the demand for reliability, the steadily increasing complexity of electronic systems, and the lack of highly skilled technicians will force automation in ground systems. They predict also that manned craft will require increased checkout speed to enhance mission safety.

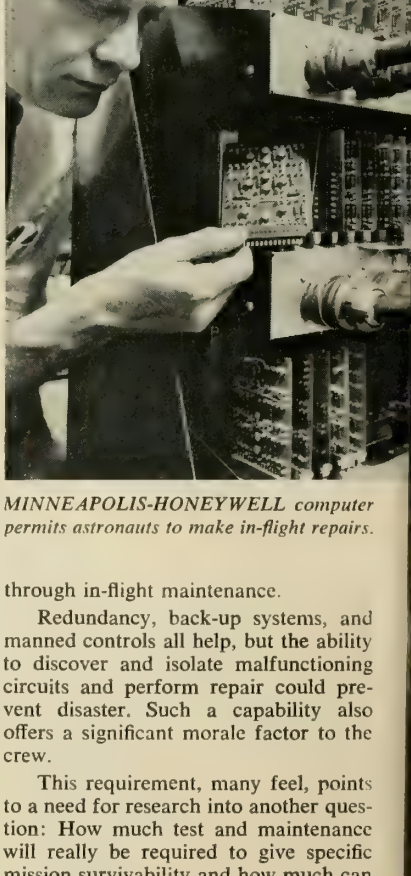
Completely automated checkout for man-rated systems has not yet been accepted. Only through experience and a continuing increase in system reliability can necessary confidence be acquired to eliminate the man-monitor in test sequences.

In ground-based systems, a major problem faced today results from the small numbers and the uniqueness of space vehicles and their boosters. Research vehicles offer greater diversity than do military systems, but both categories represent limited production.

R. E. Oster, manager of electronic support systems at Chance-Vought-Astronautics, echoed the feelings of many industry and government leaders when he stressed to M/R the urgent need for standardized checkout subsystems. Any standardization, he said, would significantly contribute to lower costs and reduce scheduled difficulties.

Not only could basic test elements be made standard, said Oster, but data could be established and published covering standardized launch-site wiring, automatic programer and test-computer configurations, test point outputs, data storage, tolerances, etc. To accomplish this, however, would require an overall research program, he said.

• **On-board checkout** — For long missions, space experts generally feel the only way to maximize the odds for survivability of manned spacecraft is through in-flight maintenance.



*MINNEAPOLIS-HONEYWELL computer permits astronauts to make in-flight repairs.*

Redundancy, back-up systems, and manned controls all help, but the ability to discover and isolate malfunctioning circuits and perform repair could prevent disaster. Such a capability also offers a significant morale factor to the crew.

This requirement, many feel, points to a need for research into another question: How much test and maintenance will really be required to give specific mission survivability and how much can be provided?

Others urge that flight equipment be designed for greater maintainability. For example, detailed research could be initiated into the standardization of circuit modules.

• **Maintenance vehicles** — Within the next 8-10 years, some test and maintenance probably will be performed on and from unmanned orbital spacecraft *(Slomar, SMART)*. This will be achieved by periodic visits of space crews from maneuverable maintenance vehicles. ⁘



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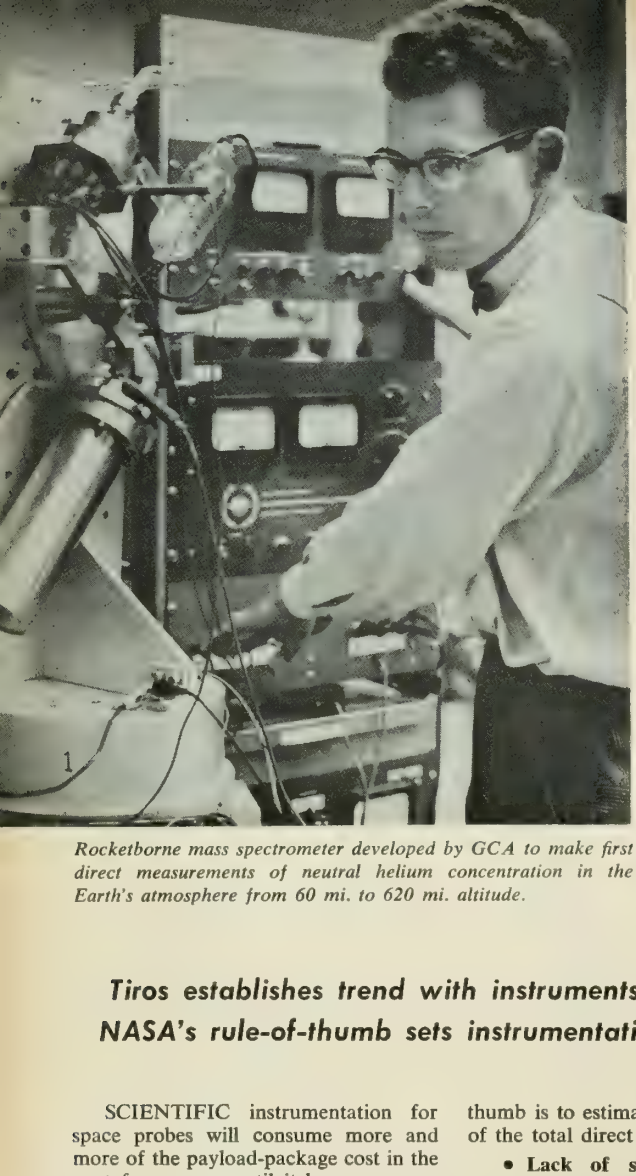
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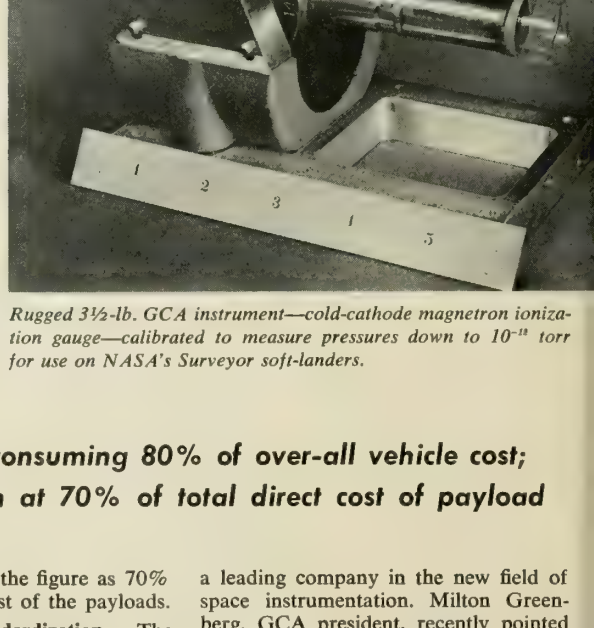
# SPACE ELECTRONICS

## SCIENTIFIC INSTRUMENTATION

# Costs Will Soo



*Rocketborne mass spectrometer developed by GCA to make first direct measurements of neutral helium concentration in the Earth's atmosphere from 60 mi. to 620 mi. altitude.*



*Rugged 3½-lb. GCA instrument—cold-cathode magnetron ionization gauge—calibrated to measure pressures down to $10^{-13}$ torr for use on NASA's Surveyor soft-landers.*

***Tiros establishes trend with instruments consuming 80% of over-all vehicle cost; NASA's rule-of-thumb sets instrumentation at 70% of total direct cost of payload***

SCIENTIFIC instrumentation for space probes will consume more and more of the payload-package cost in the next few years—until it becomes more costly than the launching vehicles.

The trend is already clear with smaller orbiters like *Tiros*, 80% of whose direct cost is for on-board scientific instrumentation.

For larger payloads, such as the *Orbiting Astronomical Observatory (OAO)* —due to fly next year—instrumentation accounts for only 40-50% of the payload's direct cost, chiefly because of a complicated stabilization problem. Cost of the *OAO* payload, however, will considerably exceed that of its *Atlas-Agena* launching vehicle.

NASA's Goddard Space Flight Center and Jet Propulsion Laboratory set up the requirements for nearly all the scientific instrumentation that NASA installs in space vehicles. Total cost of this instrumentation is not broken down in the space agency's budget. One NASA official suggests that a rule-of-thumb is to estimate the figure as 70% of the total direct cost of the payloads.

• **Lack of standardization** — The official observed that NASA is making only a small effort to standardize the scientific instruments it uses, therefore costs are relatively high. He nevertheless predicts a drastic change in the situation, reducing emphasis on contractor design before the decade ends.

Development of larger launch vehicles and auxiliary power systems will lead to space probes carrying refined instrument systems capable of simultaneous measurement of many physical phenomena. For synoptic studies, these measurements will have to be made at various locations over a fairly long period—up to tens of years, according to one estimate. This is a reason—in addition to cost—why NASA and industry will have to standardize their instrument packages.

• **Work to be done**—The Geophysics Corp. of America has become a leading company in the new field of space instrumentation. Milton Greenberg, GCA president, recently pointed up some areas of ignorance about the Earth's atmosphere (areas calling in some instances for long-time synoptic studies requiring inexpensive instrumentation systems):

—Above 50 miles, any atmospheric density profiles can be inaccurate by factors ranging from 2 to 100, with uncertainty increasing with altitude.

—For atomic oxygen, any concentration profile can be inaccurate by factors ranging from 2 to 100. For atomic nitrogen, the factors are even higher.

—There are practically no data about positive ions; ignorance is just about complete concerning distribution of negative ions.

—Most information about constituents in the region above 130 miles comes from theoretical extrapolations of uncertain lower-atmosphere data.

—There are still strong disagreements among scientists as to the nature

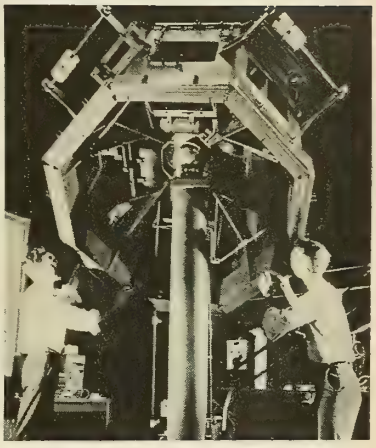
# xceed Those of Launch Vehicles



*GCA optical photon counter able to measure UV within 1050-1350 Angstrom band —shown in hand and in satellite simulator.*



*Adjustments are made on Martin Co. GIPSE, instrument to ride on Atlas and gather data on zero-gravity effects on algae.*



*Simulated OAO satellite balanced on an air bearing at General Electric facility to test aiming accuracy of orbiting telescope.*

of chemical constituents responsible for the origin of ionospheric layers.

—The nature of the wind field above 50 miles is almost entirely unknown.

For many years to come, the additional quest to understand extraterrestial phenomena is expected to accelerate the rapidly widening market for scientific instrumentation.

• **Vacuum technology**—Pressures down to $10^{-13}$ torr can be measured today, according to Dr. Alfred E. Barrington, manager of GCA's ion physics department. He expects that for the rarified gas environment in outer space and on such bodies as the Moon, the next decade will bring further development of vacuum-measuring instrumentation to gauge even lower pressures.

Concurrently with development of very-low-pressure measuring instruments, expanded studies of materials will be needed. Non-permeable materials will be sought; outgassing properties of gauge components will have to be thoroughly understood if measurements are not to be ambiguous.

"Large-volume low-pressure chambers may become a reality soon after the Moon becomes accessible to man," Barrington said. "It is conceivable that certain high-energy acceleration experiments requiring high vacuum may be carried out directly on the Moon without the large pumping stations presently required."

• **Mass spectroscopy**—Dr. Richard Herzog, GCA scientific deputy and authority on mass spectrometry, predicts great future development of the mass spectrometer for analyzing composition of the Earth's upper atmosphere and the atmospheres of other planets.

Noting that the state-of-the-art has advanced to sensitivities as low as $10^{-15}$ torr and resolutions to almost one part per billion, Herzog says "There is need for more efficient ion sources, electron multipliers and dc amplifiers to improve the signal-to-noise ratio of mass spectrometers."

As a sign of the advancing times, Herzog pointed up instruments now under development in solid-state mass spectroscopy. These do not rely on spark sources now in use: they obtain a more stable supply of ions by bombarding the solid under test with high-energy ions—several kilovolts. A certain percentage of the atoms sputtered from the surface are ionized and analyzed in the mass spectrometer.

"This type of instrumentation may be used for analysis of lunar material where the pressure of the ambient atmosphere is not expected to interfere with the measurement," Herzog said.

• **Ionospheric physics**—Direct techniques such as the Langmuir probe have proved valuable in obtaining pertinent ionospheric data above 85 km; they are still being used. RF impedance probes have been developed recently for local measurement of charge density and electron density temperature.

To obtain a more complete understanding of the ionosphere, more refined instrumentation is needed for determining electron temperature, ion concentration and composition of both ionized and neutral species.

Presently available instrumentation requires highly trained personnel for analyzing data. "It would be desirable to have more easily interpretable data output in future instrumentation," says Dr. Leslie Smith, head of GCA's ionospheric branch.

• **Solar physics**—Pressing practical reasons are pushing solar research: the need to predict solar flares for the safety of astronauts, and the need to understand the causes of ionospheric disturbances and their effects on radio communications.



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Two major task areas are of special interest:

## ADVANCE ENGINEERING

This branch analyzes existing or proposed space system designs and operational characteristics to establish system requirements and feasibility for developing design concepts. It includes these sections:

**Aeroballistics**—concerned with dynamics and trajectory analyses, aerodynamic heating, staging studies, aerodynamics, and flight evaluation.

**Preliminary Design**—establishes configuration feasibility to meet mission changes and future missions as dictated by program requirements.

**Future Systems Analysis**—studies advanced systems with consideration of tradeoffs between various parameters as well as projected availability of new and higher performance hardware.

## PRODUCT IMPROVEMENT

These programs provide for assignment involving the major elements of the structural, mechanical, and materials disciplines, including complete or partial feasibility studies, design, development, analysis, and testing. Tasks also are initiated in the areas of electrical systems, instrumentation, and automatic checkout. Component product improvement tasks will be performed to correct design deficiencies and marginal conditions detected in the evaluation and test programs.

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GCA staff scientist Carl Accardo told M/R that for these as well as purely scientific reasons, the broad spectrum of solar radiation study requires development of narrow-band detection techniques so that particular emission lines or bands may be examined.

Present detectors treat particular wave-length regions—Lyman alpha, soft X-rays. Accardo observed, however, that apart from sophisticated dispersive techniques certain regions of the spectrum are inaccessible by simple means. Filter techniques, for instance, do not exist in the 800-1025 Angstrom region —considered to be of fundamental importance in the formation of the E-region ionosphere.

• **Resonant scattering** — Investigation of the upper atmosphere by resonance scattering of solar light will require new techniques for narrow-band detection, according to Dr. Edward Manring, manager of GCA's observational physics department. Such techniques are expected to be of great value in determining the presence of trace elements such as sodium in the upper atmosphere. Moreover, they will aid in the study of upper atmosphere winds and diffusion processes.

Background radiation presently limits the desirable signal-to-noise ratio. Manring expects that development of laser-type detectors may greatly increase the potential of the resonant-scattering technique for studying the upper atmosphere. ⌘



## *Satellite Spectrometer Developed*

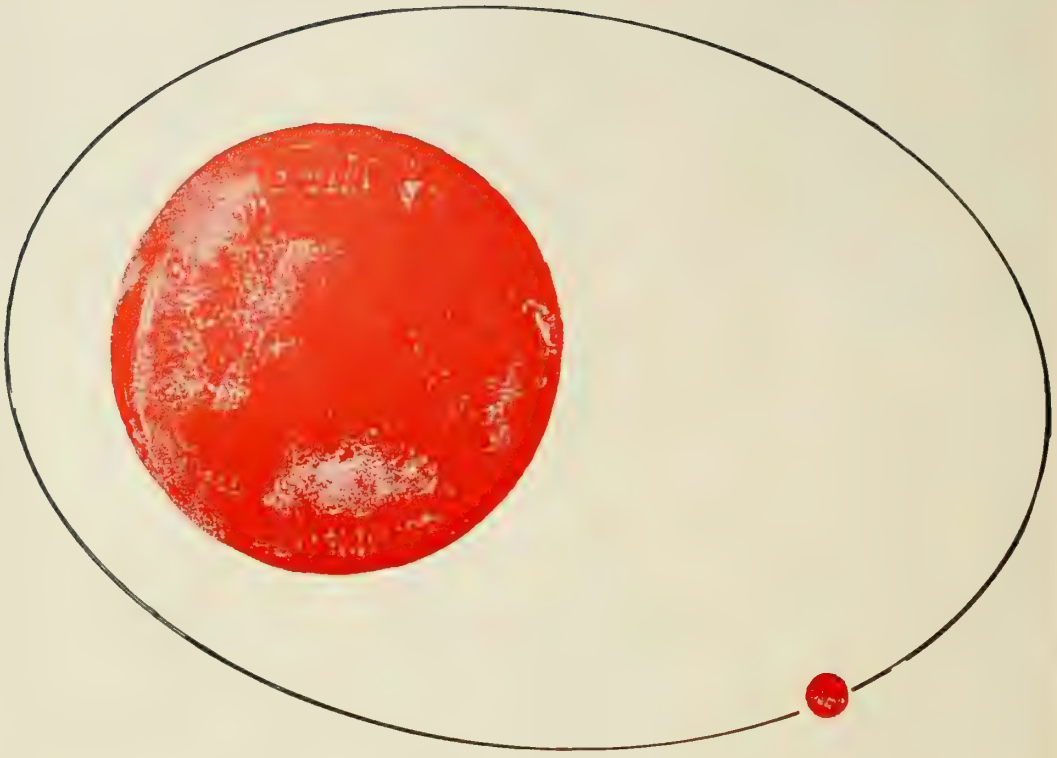
The problem of accurately forecasting weather may be eased by a technique using an infrared satellite spectrometer.

The new concept is based on determining the temperature of the atmosphere over a wide range of altitudes. Dr. L. D. Kaplan of NASA's Jet Propulsion Laboratory has proposed doing this by making simultaneous measurements from above the atmosphere of the infrared energy emitted in the 15-micron carbon-dioxide band at several wavelengths.

These measurements would make it possible on a theoretical basis—with certain assumptions about the atmosphere's thermal stratification—to deduce the temperatures at several different pressure intervals in the atmosphere.

A prototype spectrometer (above), developed for this purpose, is now undergoing tests and evaluation at the Meteorological Satellite Laboratory of the U.S. Weather Bureau.

After these tests are completed, the instrument is scheduled for checkout on a high-altitude balloon flight, and then on a weather satellite.



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# Reliable Radiation Test Data Needed

## *Earthbound experimental results difficult to extrapolate for space*

PERFORMANCE of solid-state and other electronic systems functioning in the space environment is predicated on an enormous mass of empirical data—and very little fundamental understanding of the mechanisms involved.

With respect to radiation effects alone, Dr. Bernard Manning of the Air Force Cambridge Research Center says there exists a need to develop in detail a basic knowledge of how radiation moves atoms about, the range of movement of secondaries, the energy levels produced, the energy-effect and dosage-effect relationships, the permanence or additivity of the changes and the interaction between these changes in a given material.

In the past, says Manning, testing programs have been based primarily on reactor data results, and because of the complex spectrum of energies present, these data have been difficult to interpret in terms of fundamental events.

An additional complication has been that the neutron energy spectra differ in the different reactors and in different locations in the same unit. All this makes it difficult to extrapolate to practical situations.

• **Particle behavior** — Uncharged neutrons will approach any target but produce no effect on other particles except after a collision. Because of their relative sizes, neutrons will usually collide with a nucleus rather than with electrons.

After a collision, the now-charged energetic particle collides with other nuclei, dislodging them as well as many electrons. In the same manner, protons impinging on a target will also collide with nuclei and dislodge electrons.

Charged particles are more effective in freeing electrons from their bonds when moving slowly because of the longer reaction time available, says Manning. Neutrons will frequently displace $10^3$ to $10^4$ or more atoms, while protons will effect fewer. Electrons will displace one to 10 atoms and gamma rays will displace one or more atoms if there is conversion.

The most noticeable effects of these interactions resulting from radiation are the crystalline defects and the energy released from the increased number of electrons free to move until trapped. Atomic displacement — crystalline defects — produces permanent effects, while electron energy generates temporary effects. There are also nuclear transmutations and delayed effects.

Ionization events, resulting from the released energy, have a relaxation period during which the electrons in the conduction band revert to a more stable energy level. The number of electrons placed in the conduction band is a function of the kind and dose of radiation causing the ionization.

The transient effects of radiation produced in electronic devices may cause other effects a considerable distance from the particular "target" area, since all parts of an electronic circuit are interrelated. The immediate effect of transient radiation pulses is revealed by the presence of conduction electrons, which may provide leakage paths and/or alternate conduction loops. The result may be a noise signal induced in the circuit where a pulse would not normally exist or an alteration of a signal normally present.

The transient effect itself does not usually last much longer than the radiation pulse and the extent of the alteration is somehow related to the pulse intensity, says Manning.

Permanent effects, residual after the occurrence of the pulse, depend on

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|---|---|---|
| ALTITUDE | 1400 – 3400 KM | 8000 – 12000 KM |
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| PROTON FLUX | $2 \times 10^4 p/cm^2$-sec > 40 mev | |
| ELECTRON FLUX | $\sim 10^{10} e/cm^2$-sec > 20 kev<br>$\sim 10^7 e/cm^2$-sec > 600 kev | $\sim 10^{11} e/cm^2$-sec 40 kev<br>$< 10^8 e/cm^2$-sec > 200 kev<br>$< 10^6 e/cm^2$-sec > 2.5 mev |

the type of material, and result in such phenomena as increased resistivity (as when n-type germanium is converted to p-type), increased brittleness in conductors, variation in the frequency of oscillation of quartz crystals, induced voltages and chemical changes.

Permanent effects are cumulative. Manning says present data indicate they are largely independent of dose rate.

The devastating effects of radiation are so great that it isn't possible to develop impervious materials. Manning illustrates this point by noting that electronic binding energies are measured in no more than tens of electron volts, and the energy required to move an atom by collision with an electron in hundreds of kilovolts, but the energies of ray particles are described in millions of volts.

• **Protection**—Shielding and design are two protective methods under study. The cheapest and lightest shield is usually distance—because radiation intensity decreases with the square of the distance between source and target, with the specific exception of beamed particulate radiation. Mass is also used by blocking the radiation with an inactive body.

Devices and circuits can be designed to accommodate the effects of radiation up to certain stated limits without excessive deterioration in functional performance, says Manning. This is achieved by using distance — locating the less radiation-sensitive components outside the circuitry.

It can also be accomplished by incorporating redundancy or parallelism into the design, or by blocking out, during pulses, portions of the system by radiation sensors.

Manning says a combination of materials knowledge, circuit design and shielding design can be parlayed into circuitry capable of handling not only radiation fields generated by nuclear explosions, but also Van Allen Belt, proton flares and other radiation fields which may be encountered.

Even with the relatively simple types of radiation environments we now know exist, says Manning, there are considerable complications.

Most current data is derived from experiments with nuclear power packages. Yet Manning says this type of radiation environment is no less difficult to describe accurately than is space radiation. Fundamentally, the observed phenomena are not varied in kind but in degree, and the difficulties of interpretation lie as much in the complexities of the materials and devices as in the physical phenomena. Manning describes briefly the phenomena as they appear in certain of the more commonly used devices:

• **Resistors** — Carbon composition resistors are extremely variable in manufacture. Manning says it is a problem just to determine whether the changes are due to radiation, interfacial contact changes, humidity or some other cause. Resistors of this type exhibit a decrease in resistivity of approximately 3-10% during irradiation under fast neutron flux of the order of $10^{15}$, an integrated thermal flux $10^{18}$, or a gamma dose of $10^{11}$ ergs/gm (C).

The cause of these changes may be the decomposition and carbonization of the epoxy binder. The variation of effect with resistance value is related to the relative quantity of binder.

Pulsed radiation, available from reactors such as *Triga* or *Godiva,* produces an instantaneous decrease in resistivity as high as 86% for high value resistors. This decrease may be due to the setting up of surface leakage paths rather than to variations of binder or bulk materials.

Deposited carbon film resistors are even more complex in manufacture and composition. Usually the thickness of the film is within the range of the recoil of a displaced carbon atom—the higher the value, the thinner the film.

Manning says it may be that the atomic displacements actually tear out chunks to decrease the effective film thickness and thus increase resistivity, or that displacements actually increase the difficulty of movement of electrons in the film. But he says this is more of an excuse for observed data, not an explanation.

Negative resistance changes are noted in resistors coated with methacrylate. This is excused by postulating the existence of ionization, and thus alternate leakage paths.

Metal film resistors show an increase in resistivity, as expected, because atomic displacements would increase electron scatter. A decrease would be expected, says Manning, and has been observed, when coating materials other than metal are used.

Wire-wound resistors are least sensitive to radiation since they present a continuous path for the flow of electrons. An increase in resistivity results from increased electron scatter. For some reason, pulsed radiation results in a considerable increase in resistivity, which may be related to the induced electromagnetic field in the wire coil and the back EMF generated. Manning concludes that little is really known about fundamental processes in resistor materials.

• **Varistors**—Nonlinear voltage sensitive devices such as copper or selenium oxide rectifiers are also sensitive to radiation. The character of the oxide film changes easily due to collisions with particles and the secondary products of such collisions. Dosages as low as $10^{13}$ n/cm$^2$ produce appreciable changes. The symmetrical varistors—such as compacted silicon carbide powders—have a considerably greater radiation accommodation.

• **Capacitors** — The myriad types of capacitors available force Manning into some generalizations. The aluminum film is essentially undamaged by radiation, but dielectrics and supports are not so immune. Organic dielectrics change chemically by decomposition, carbonization or polymerization. Inorganic dielectrics are much more stable.

Electrolytic capacitors containing boron, which has a high neutron-capture cross-section, have low radiation tolerances. Solid dielectrics of aluminum oxide, magnesium oxide and boron nitride undergo little change in a static radiation flux. A decrease in leakage resistance accompanies a pulse because of ionization in the dielectric, says Manning.

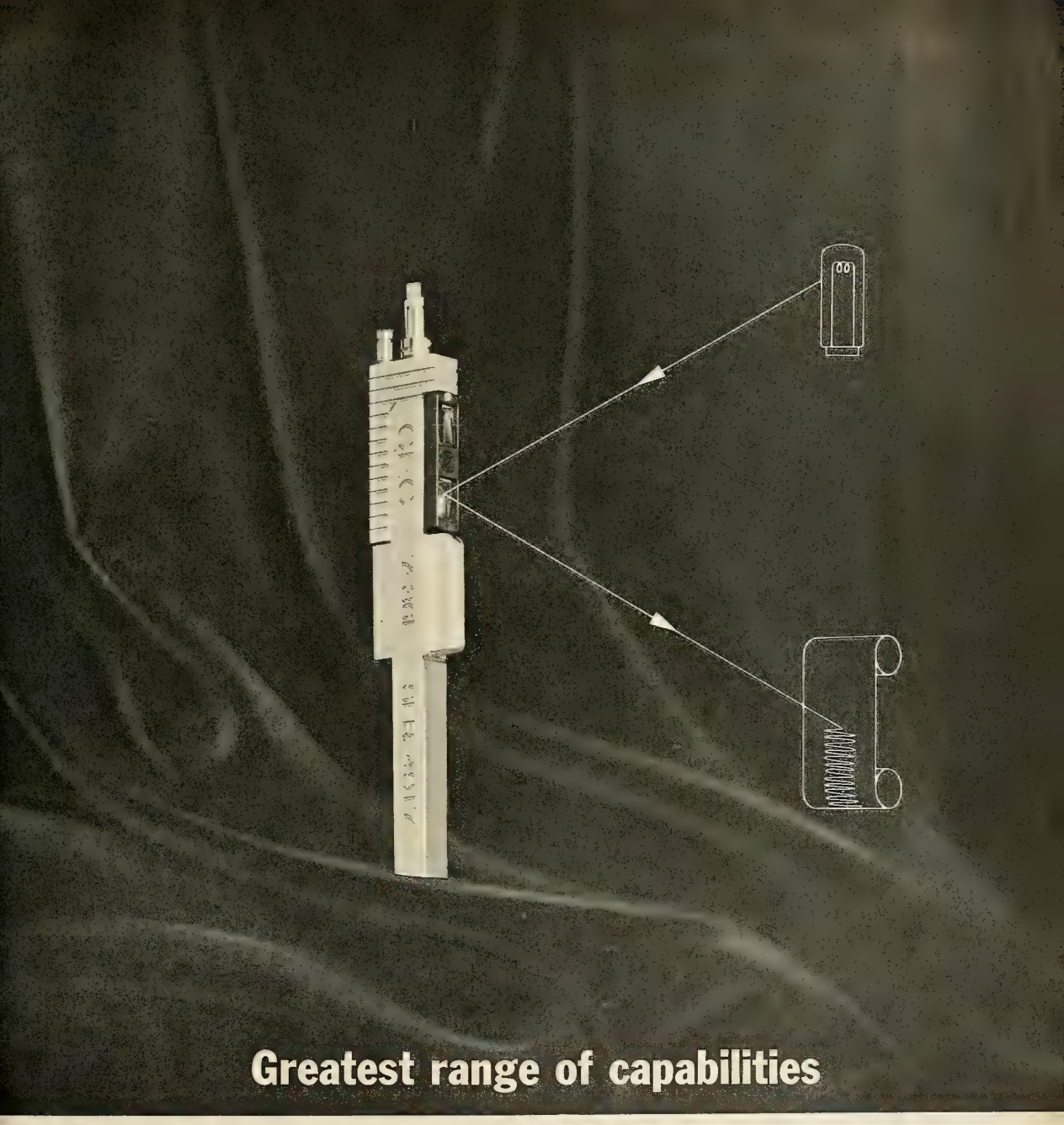
• **Transformers** — These devices can withstand neutron doses in the order of $10^{17}$/cm$^2$ without marked changes in characteristics—provided no mechanical change takes place. Potting compounds, usually organic, undergo chemical changes and become gassy. The organic insulation between windings suffers similarly, causing short circuits.

• **Infrared Detectors**—Semiconductor types such as PbS, PbSe, InSb and thermistors have been studied in both pulsed and continuous radiation fields. The signal to noise ratio decreases after about $10^{13}$ neutrons/cm$^2$, decreasing essentially to zero at doses of $10^{16}$.

Bolometer thermistor types have the best radiation accommodation, says Manning, and irradiation results in a decrease in dark resistance. Window materials such as $CaF_2$ tend to become less transparent, but this transmission loss can be annealed out and is minor compared to the signal-to-noise ratio change of the detector itself.

• **Transistors** — This component is the most satisfactory for purposes of study, says Manning, since its structure and chemical composition are known and irradiation results are relatively easy to measure. The Cambridge expert feels the narrow-base transistors are frequently rediscovered as having the best accommodation to radiation changes. From a simple geometric viewpoint, the narrow base presents the least mass target.

Electrically, the narrow-base unit permits radiation-injected minority carriers to pass through without recombination. Lifetime changes are a function of the recombination cross-section of the defects. ⁘



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## Communications

*(Continued from page 47)*

According to an ITT report, maximum peak output power from a single ground transmitter in the 1970 period will be about 50 mw. Between 100 and 500 mc, the report states, this value of power is relatively independent of frequency. Above 500 mc, available peak power decreases with frequency, giving about 10 mw at 10 kmc.

Beyond the large aperture dish is the possibility of widespread operational use of electronically steerable phased arrays. These devices, though expensive, are attracting considerable development money as a means to generate practically unlimited ground power. They may also offer a better way to control side lobes.

Though phase shift and coupling problems remain, the phased array could be a way around the inherent deformities and handling difficulties of the large single apertures. The ability to harden some of these designs is also making them attractive to the military.

• **Planet network**—In another antenna area, design work will continue on devices which can be dropped on the Moon, Mars, or Venus as part of a relay network.

The optimum frequencies for space communications fall between 1-10 kmc in the microwave region. The useable upper figure varies. Some estimate it to be as high as 12-15 kmc. Beyond these frequencies, water vapor causes sharp increases in signal attenuation and noise.

There are some windows higher up in the spectrum, notably in the millimeter and sub-millimeter bands (30-3000 kmc). But these are generally not zero-attenuation bands and though some special purpose use may be made of them (plasma sheath communications and special control assignments from particular geographic locales), these routes probably won't get widespread operational attention, at least in the near future.

Component efficiency limitations will keep space-probe and scientific-satellite frequencies in the low end of the 1-10 kmc band for the next few years, with ComSats occupying mostly the middle latitudes. Movement to higher frequencies will eventually come to take advantage of the greater range, bandwidth, low-noise, and antenna gain vs. size improvements.

Traveling wave tubes, by virtue of improved power, efficiency, and reliability, are assured of a relatively long life and are not apt to be displaced by solid-state devices for some time. Additional R&D here will go into improved focusing schemes and lowered cathode temperatures.

Most of the multitude of constraints and trade-offs that impinge on designers of space communications systems, making almost any design-margin db uncertain, are found in the spaceborne end of the package.

• **Improvement called for**—There will have to be long-range improvements in satellite antenna directivity and gain, on-board receiver sensitivity, source power (see p. 57) and output power. Many of the needs here, though not directly considered part of the communications package, will have the greatest effect on improved RF links.

In this category falls the need for reliable, long-life, multi-axis attitude control, and development of efficient power sources able to supply the wattage for high bit-rate data transmission over interplanetary distances.

There are no easily definable parameters for space transmitter power. With a high-gain directional antenna on the spacecraft and a sensitive receiving facility on the ground, a few watts is sufficient to get data back from Mars, though at slow rates. A 10-watt transmitter is said to be sufficient for multi-user ComSat use.

There is pressing need for accurate (to within about ±3 deg) long-life attitude control systems which will allow use of high-gain directional antennas. Many feel these devices can be developed and space tested in building-block fashion with considerably less risk and expense as appendages to various scheduled payloads rather than as a critical part of a complex system. There have been no three-axis systems flight tested to date (*Advent* would have used one).

Use of gravitational and magnetic field effects will be further explored as a means to assist in the stabilization problem. Systems employing gas jets will certainly be used. However, inherent supply limitations will force additional R&D on electrically driven inertia wheel approaches.

With stable platforms, antenna gains of 16-18 db will be readily achievable. Rigid and fixed parabolic antennas will probably be size limited to less than 6-ft. dia. due mostly to drag and field of view problems. Large erectable or inflatable devices, now getting a lot of attention, may be five or six times that size. Eventually, with the move to higher frequencies, antenna size will again be reduced with no loss in gain.

Many observers believe it will be more efficient and economical to go to directional antennas, given the accompanying problems and equipment of attitude control systems, than it is to press for greater on-board power with omnidirectional array devices. ⁂

# Information About Hose Made of Teflon From The People Who Invented It

**No. 2 in a series**

## ORIENTATION AND HOSE OF TEFLON

One of the many important parameters that a knowledgeable manufacturer of Teflon* hose tubing controls is the orientation of the building blocks of the resin, often called crystallites. It is generally understood that the specific technique of extrusion has influence over the degree of orientation of the particles; not so common is the knowledge that the subsequent manufacturing steps, sintering, etc., are far more important than extrusion for controlling properties of the tubing.

Recently spiral extrusion techniques have been advocated as a method of improving hose tubing. Counter-rotation of male and female dies during extrusion produces two spirally oriented layers of particles. However, Teflon tubing structure is determined at the micro level, and the post-extrusion processing steps exert greater influence in this area than specific arrangements of bands of particles. In other words, two-directional orientation (two massive bands of oriented particles), by itself, is still far from true "random orientation" of the little building blocks.

Maximum randomizing during the manufacturing operations provides the highest level of performance in terms of flex life, fatigue resistance and all the other desirable mechanical attributes of good tubing. The freedom from spiral delamination, cleavage planes and circumferential fracturing afforded by maximum randomizing is not easily attained. Although this implies that manufacturing operations are critical, such is not the case, since the control of the manufacturing process, although strict, is relatively routine after knowledge and understanding of the product have been achieved.

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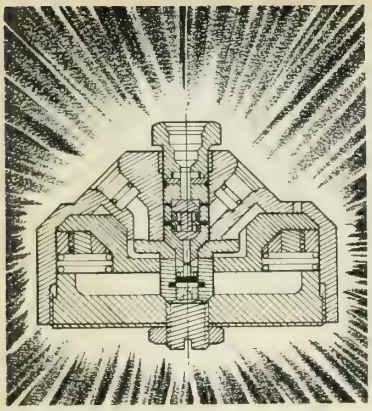
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The Model 4890 has the following important advantages over conventional regulator designs: (1) Relatively small for a unit with its capacity and capability; (2) No vibration damping devices used, thus permitting use of very minimum number of parts. This provides high degree of reliability; (3) Simple temperature compensation system minimizes set point drift . . . providing wide usable temperature range.

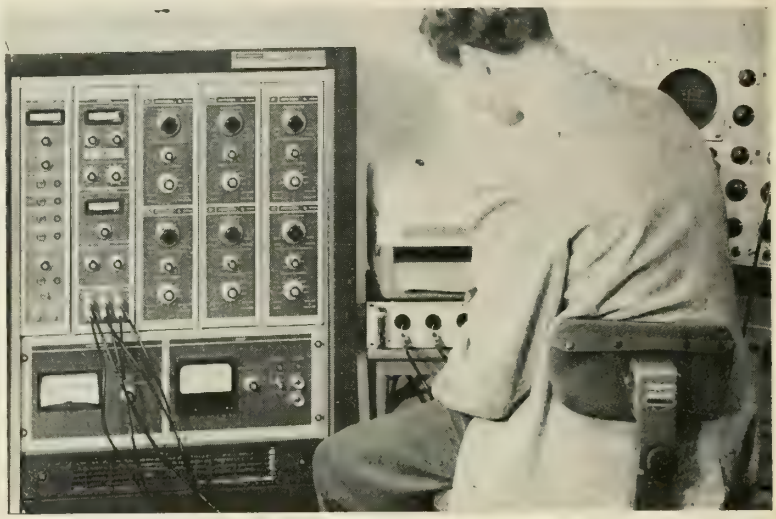
This basic design is adaptable to many applications.

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Circle No. 32 on Subscriber Service Card

## *New Product of the Week:*
## *Mass Spectrometer*

A portable time-of-flight mass spectrometer has been developed by the Cincinnati Div., Bendix Corp. The Model 17-210 has application in space research such as cryogenics, high vacuum component testing and the analysis of residual gases in ultra-high vacuum chambers of $10^{-12}$ torr.

By use of pulsed ion optics, 10,000 spectra per sec. are presented covering the mass range of 1 to 250. The sample is seen on an oscilloscope, and less than 10 sec. later, is recorded on a strip chart. It will record the entire mass spectrum while simultaneously recording up to five preselected gaseous components.

When used for residual gas analysis, a special open ion source is the heart of the instrument. This projects into the test vacuum chamber to insure that analyses are made of the residual gases being investigated rather than any gases originating in the mass spectrometer. The ion source region can be baked out at temperatures up to 450°C for sustained periods. This eliminates background contribution.

Circle No. 225 on Subscriber Service Card

### Electronic Voltmeter

Keithley Instruments, Inc., is marketing a wideband voltmeter for measurements in the 10-cps-100-mc spectrum. Designated Model 120 Wideband Voltmeter, it employs ultra-high-frequency transistors in its amplifier circuits to achieve a bandwidth 20 times greater than that of vacuum-tube voltmeters.

Model 120 offers features heretofore unavailable in a single instrument. Its bandpass, sensitivity and amplifier output provide the means to measure nearly any ac signal.

Circle No. 226 on Subscriber Service Card

### Zero Insertion Force Connector

Micropak is marketing a zero insertion force connector which features a dial-to-lock holding mechanism. Designed to save time in "bread-boarding" and component and module checkout, unit is the first multi-socket connector of its type to be marketed.

This connector accepts up to 100 wires in sizes from 0.010 in. to 0.032 in.—ideal for use with semiconductors and plug-in modules. Wires are simply inserted into holes and simultaneously locked by turning the knob a half turn. Low-contact resistance sockets can be pre-wired for immediate check-out, eliminating soldering, clip leads, and handling minute wires with tweezers.

Though Micropak dial-to-lock mechanism holds wires securely, wires can be pulled out in event of a short-circuit without damaging the component under test. Unwired connectors can also be used as assembly or soldering jigs during manufacturing processes.

Circle No. 227 on Subscriber Service Card

## Motor Generators

A series of size eight 400-cycle servo motor generators featuring high signal-to-noise ratios and short length has been developed by Kearfott Div., General Precision, Inc. Obtainable in a wide selection of functional variations, these motor generators are designed around a single high gain generator (CMO 0740 001) to which one of six different size eight motors may be integrally coupled. Motors, which include standard, low-




inertia four-pole, and low-inertia six-pole types, and the generator are also available as separate components. Excitation motor voltage is 26 volts on the fixed phase of all units, with control phase voltages of either 26 or 33 volts in series, and either 13 or 16.5 volts in parallel.

Circle No. 228 on Subscriber Service Card

## Single-Sideband Crystal Filters

Models F2211, F2212, F2213 and F2214—all single-sideband crystal filters designed specifically for telecommunication receivers with a carrier frequency of 250.000 kc — are available from Reeves-Hoffman. Carrier attenuation is 30 db minimum for F2211 and F2212; greater than 20 db for F2213 and F2214. Models F2211 and F2213 are upper sideband types; F2212 and F2214 are lower sideband. Case configuration may be adapted to meet designated practical requirements. Impedance level may be specified over a wide range. Sipple is 1.5 db maximum for F2211 and F2212; 3 db maximum for F2213 and F2214.

Circle No. 229 on Subscriber Service Card

## Heat Sink Isolators

Perfection Mica Co. is marketing a complete line of thin, dielectric-grade mica film isolators for higher voltage heat sink semi-conductor and transistor applications. Shorting hazards are minimized because the mica films have high mechanical sheer and piercing resistance. The insulators have a thermo gradient of 0.05°C/watt and are contour blanked for all standard power transistor and semi-conductor configurations.

Circle No. 230 on Subscriber Service Card




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Available in 50 and 100 VDC ratings in values from .001 to 1.0 mf.
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Circle No. 49 on Subscriber Service Card

## Signal Sampling Network

Designed for use with high-power transmitters, a broadband signal sampling network that measures spurious and harmonic signal with 3± db accuracy has been introduced by Electromagnetic Technology Corp. With an optional zero-db coupler, EMTECH's direct-reading instrument can monitor such signals while the fundamental frequency is coupled to antennas.

Model SSN also measures the full tube power output calorimetrically with 5% accuracy. By use of a high-power, water-cooled attenuator, the high power of the transmitter is attenuated equally for all propagating modes. EMTECH's mode mixer employs a time-sharing mode alignment technique to assure accurate measurement of total power carried in the various waveguide modes. Harmonic frequencies are coupled on separate terminals by a band separation filter (second and third harmonics standard, higher orders on request).

Circle No. 231 on Subscriber Service Card

## Counter-Timer

A counter-timer containing decade counters of a completely new type is available from Anadex Instruments, Inc. Called the Anadex Counter-Timer Model DF-200, it measures frequencies of 0 to 120 kc over one-tenth, 1 and 10 second intervals. Period averaging is provided over 1, 10, and 100 input cycles.

Timing intervals of this unit are from $10^{-5}$ seconds to 11.6 days. Totalizing is either manual or remote-electronic gating. It features an input sensitivity of 10 mv, permitting use directly with low level signals.

Each decade is made up of a ring of 10 toggles, utilizing the Nixie tube itself as an active element of each toggle. No power amplifiers or high-voltage driver transistors are used.

Circle No. 232 on Subscriber Service Card

## Rotary Actuator

A high-speed rotary actuator with remote selection of any of 12 equally spaced positions—applicable to switching and other stepping applications is available from the Bendix-Pacific Division of Bendix Corp. The unit incorporates a permanent magnetic dc motor coupled to a 12-position Geneva mechanism.

Weighing only 8 oz. and smaller than a pack of cigarettes, the switch provides 20 oz./in. of torque at 45 rpm, and 125 oz./in. at stall, with a rated life in excess of one million cycles.

Circle No. 233 on Subscriber Service Card

## Laser Crystals

Isomet Corp. is making available standard, calcium tungstate-dopes boules capable of being fabricated into laser rods up to ¼-in. dia. by 5-in. long and ½-in. dia. by 4-in. long. On special order, Isomet can supply ¼-in.-dia. laser rods upto 10-in. long and ½-in.-dia. rods up to 6 in. long.

The larger sizes are expected to open new fields for laser development as they permit pumping at appreciably higher levels. They will be available in boule form or as fabricated rods with ends polished optically flat, parallel, confocal, spherical or faceted to meet special needs.

Circle No. 234 on Subscriber Service Card

## Miniature Infrared Radiometer

Measurement Systems, Inc. has a miniature infrared radiometer which can be used as a radiometer, calorimeter, or remote temperature sensor. Radiometric sensitivity is $4x10^{-12}$ watts/cm$^2$ ($3.6x10^{-12}$ BTU/Ft.$^2$-sec.). The unit can detect a 1° C change (at 25° C) in a distant object which fills its 1 degree angular field of view. The response time is one millisecond.

Circle No. 235 on Subscriber Service Card








Circle No. 33 on Subscriber Service Card

## Signal Sampler

A signal sampler available from Astrolab, Inc. using ferromagnetic material to give broader band width and lower VSWR, has an adjustable 50 ohm



line coupled with coil type loop to monitor the level of magnetic RF energy on the main transmission line. A safety device is incorporated to prevent damage to loop. This adjustable line can be positive locked in any position.

Circle No. 236 on Subscriber Service Card

## Instrumentation Recorder

An advanced laboratory recorder having seven bi-directional tape speeds, solid-state electronics, error-proof push-button operation and facility for control by digital programmers is available from Precision Instrument Co. Capstan speed is held accurate to within 0.02% by phase lock to a crystal-controlled reference frequency. Tape tension is held constant by a sensitive electronic servo system which regulates the torque of d-c reel motors. All seven tape speeds—including forward and reverse speeds of 1⅞, 3¾, 7½, 15, 30, 60, and 120 ips—are electrically selectable.

Circle No. 237 on Subscriber Service Card

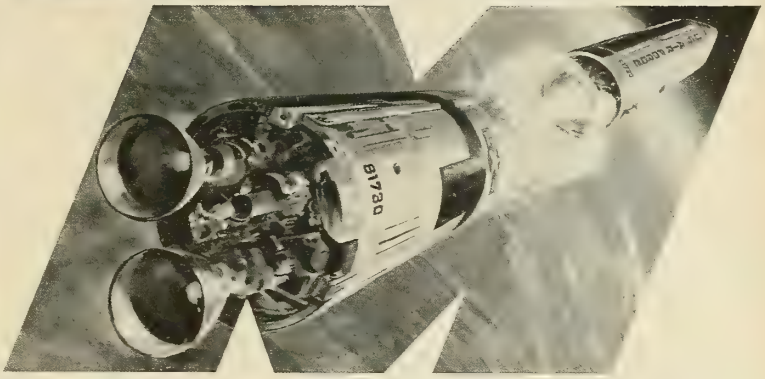
## Rectangular Trimmers

A line of rectangular trimming potentiometers is available from Spectrol Electronics Corp. The three basic models (40, 42 and 44) are available in several terminal types, including Teflon-insulated stranded leads, PC pins and solder hooks. They are directly interchangeable with other types adopted as industry standards.

All Spectrol rectangular trimmers comply with the requirements of the new ASESA specification MIL-R-272-OBA including moisture resistance and immersion. The molded diallyl phtalate housing provides a dimensionally stable, nonhydroscopic trimmer body. Unique spring-loaded slider block design insures anti-backlash operation for setting stability, eliminating rock in high-shock and vibration environments.

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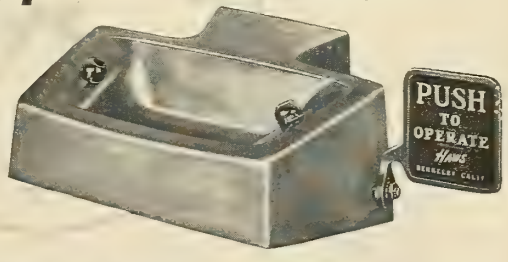
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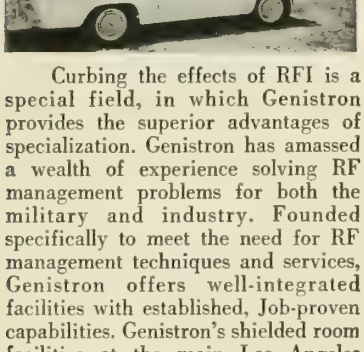
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## *RFI PROBLEMS CALL FOR SERVICE BY SPECIALISTS*

As a basic threat to electronic equipment performance and reliability, Radio Frequency Interference commands major concern today. No longer regarded as merely a nuisance, its often costly, sometimes tragic consequences underscore the need for effective control methods: A missile launching is ruined by premature triggering of electro-explosives . . . a plane's safety is threatened when interference critically disrupts communications . . . errors are caused, impairing computer calculations.



Curbing the effects of RFI is a special field, in which Genistron provides the superior advantages of specialization. Genistron has amassed a wealth of experience solving RF management problems for both the military and industry. Founded specifically to meet the need for RF management techniques and services, Genistron offers well-integrated facilities with established, Job-proven capabilities. Genistron's shielded room facilities at the main Los Angeles location, and in the Chicago area, are among the largest available to industry, and are strategically located for nationwide service. Capabilities cover the full RF spectrum. The company's wide range of service encompasses RF systems management, RFI measurements, certification, and correction to various military RF specifications — MIL-I-6181D, MIL-I-26600, MIL-I-16910A, MIL-I-11748A, GM07-59-2617A — and to FCC requirements. In addition, Genistron is a leading producer of RFI filters to military specifications.

Available for consultation at your facility or in Genistron's Laboratories, Genistron field engineers bring a specialist's knowledge to bear on your particular RFI problems.

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## Waveguide Noise Sources

A complete series of matched waveguide noise tube mount assemblies for use over the frequency range of 2.6 to 40.0 Gc is available from Waveline, Inc. These precision noise sources have been designed to provide an excess noise power of 15.2 ±0.5 db above random noise at room temperature (KTB at 290°K).

The precision units are supplied in eight standard waveguide sizes. Argon discharge tubes are included with each tube mount, and a cable for connecting to the standard Waveline power source is an integral part of the noise tube mount assembly. Average VSWR over the complete waveguide frequency range is approximately 1.07 with a maximum of about 1.13. Insertion loss of the unlighted tube is negligible because of the basic broadband design and the low-loss glass material used in the tube construction.

Circle No. 239 on Subscriber Service Card

## Tape Rewinder

Omnitronics, Inc., subsidiary of Borg-Warner Corporation, is marketing a high-quality tape handler specifically for use in rewinding paper or magnetic tape from one reel to another. Reels up to 10½ in. dia. are accommodated on the Model RS-210 rewinder; rewind speed averages 60-in./sec. The drive system incorporates protective interlocks and dancer-arm controls which prevent tape breakage as tape builds up on the take-up reel.

Circle No. 240 on Subscriber Service Card

## Test Fixture

The JFD Electronics Corp. has developed a universal text fixture designed for critical measurement of resistance, capacitance, and Q factor of a wide variety of electronic components and circuits. It permits quick measurements with high accuracy and speed, and includes 12 easily and quickly interchangeable accessories.

Circle No. 241 on Subscriber Service Card

## Glide Slope Antenna

Sparton Electronics Div. of Sparton Corp. has designed, developed and quantity-produced an I.L.S. glide slope antenna, AT-983-ARN, for the U.S. Air Force. Designed to MIL-A-6325, MIL-E-5400 and MIL-3-5272, the antenna is 4½ in. long, 4-13/16 in. high and 2 in. wide. It weighs only 8 oz.

Specifications are: Frequency range—329-335mc; polarization—horizontal; impedance—50 ohms; VSWR—less than 2.5:1; temperature range 54°C to 125°C; altitude—80,000-ft.

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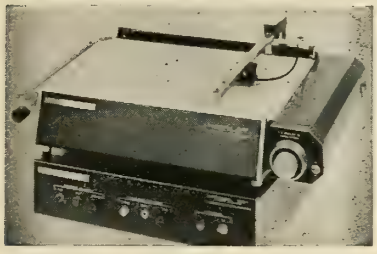

Circle No. 35 on Subscriber Service Card

Circle No. 36 on Subscriber Service Card

## Graphical Data Reader

An instrument for reading pre-recorded graphical data and assisting in the control of production operations is being marketed by F. L. Moseley Co.

The Model 231 produces an analog electrical signal representing a process



control or experimental operation and the chart transport may be operated at six accurately calibrated speeds of 2, 4, 8, 16, 24, and 32-in. per min. The model 231 reader features an alarm circuit and relay mechanism which is activated when tracking errors are detected of as little as 0.1 in. on slopes to 60 degrees.

Circle No. 243 on Subscriber Service Card

## Tape Delay System

A magnetic tape delay system that accurately provides a continuously variable time lag of 0.3 to 10.0 sec. has been developed by Mnemotron Corp., a subsidiary of Technical Measurement Corp.

The 102-DR magnetic tape is a solid-state system for use whenever an on-line signal delay is required, for example, simulating delay time in analog computer problems, simulating transport lag in industrial process control systems, or duplicating physiological reaction times in the medical field.

The entire system comprises a tape delay transport mechanism and two data converters. The system has a linearity of 0.2% of full scale and a frequency response of 0-400 cps at 7½ ips, and 0-100 cps at lowest tape speed of 1⅞ ips. With extended response Model 102-DR, frequency response is doubled.

Circle No. 244 on Subscriber Service Card

## Metallized Capacitors

A series of ultra-thin film 100v dc metallized Mylar capacitors available in a wide range of capacitance values and providing up to 50% space savings over previous metallized Mylar units is available from Hopkins Engineering Co., subsidiary of Maxon Electronics Corp.

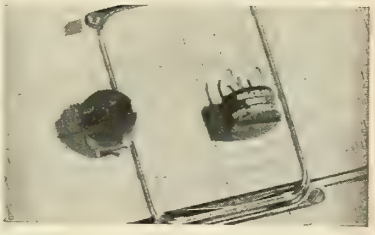
Standard values in the capacitors range from 0.001 MFD to 30.0 MFD, with a standard capacitance tolerance of ±20%. Closer tolerances down to ±1% are available in capacitance values of 0.5MFD and up. The units can withstand 140% of rated voltage for 250 hours at 125°C when surge current is limited to five milliamperes. They are operable at temperatures from −55°C to +100°C without derating and may be operated up to 125°C with a 50% voltage derating.

Circle No. 245 on Subscriber Service Card

## Microminiature Transformer

A microminiature transformer adaptable for use in lunar probe vehicles and a space environment has been developed by Hughes Aircraft Co.

Designed initially for lunar spacecraft and for use in a hard vacuum environment, the company's latest addition to its family of microminiature transformers and reactors can be sub-




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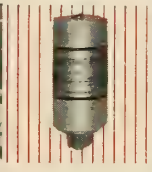
**Welex Electronics** specializes in the application of system oriented techniques to the reduction of RF interference. A growing list of "RF Quiet" components is available from Welex Electronics for use in systems where compliance with RFI specifications has become mandatory. Welex Electronics determines RFI specification compliance for space, air, land or sea missions either in the field or in the laboratory.

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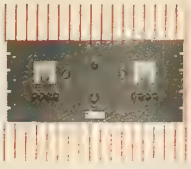
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Power Supplies

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stituted for existing transformers with a considerable reduction in weight and volume. The unit is designed with close tolerance terminals for printed circuit board use and has electro-tinned nickel terminals for soldering or welding.

Circle No. 246 on Subscriber Service Card

## Pushbutton Analog Computer

A moderately priced, console model electronic analog computer with central push-button control and monitoring is available from Applied Cynamics, Inc.

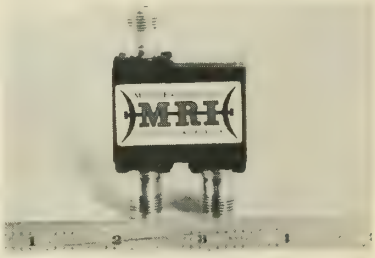
Designated AD-2-64-PBC, the computer offers the operating speed and convenience of central controls and the flexibility of a removable, color coded patchboard, to provide computing capability for university, industrial, government, medical and military applications.

Four control modules are offered with the computer: computer control module; voltmeter module; input-output module; and address selector module.

Circle No. 247 on Subscriber Service Card

## Four-Port Circulator

A small four-port circulator offering frequency ranges over the C, X, and Ku bands is available from Micro-Radionics, Inc. Using strip transmission line, complete miniature microwave systems now can be laid out as a unified part, without intermediate connectors. This will permit construction of a mechanically stable package with increased reliability at economical cost. Typical of the




characteristics of M-R-I ultra-miniature products are the specifications for their four-port circulator. These are: Insertion Loss: 0.5 db maximum; Isolation: 20 db; VSWR: 1.25 maximum; Size: 1¼ in. high, ¾ in. deep, 1⅝ in. wide. Weight: 3 oz.

Circle No. 248 on Subscriber Service Card

## Shift Register

Navigation Computer Corp. is marketing the Model 408 Shift Register, which has at each of its five stages set and reset inputs, assertion and negation outputs and neon indicator. Common shift, reset, transfer set, and transfer reset busses are connected to all stages. It is possible to cascade Model 408's to form a shift register of any length.

The Model 408 is one of a complete line of digital modules from NAVCOR. Each module performs a complete system function, such as binary-coded-decimal counter or reversible-shift register function. Special features include MIL-Spec components and simplified loading rules which cover both static and dynamic loading to make full use of the circuit capabilities.

Circle No. 249 on Subscriber Service Card

## Traveling Wave Amplifier

A high-gain, broadband CW traveling wave amplifier is available from Litton Industries' Electron Tube Div.

The 22-oz., conduction-cooled unit, designated L-3769, provides a minimum CW power output of one watt with 60 db minimum small-signal gain over the frequency range of 5400 to 11,000 mc; and two watts CW, with 65 db minimum small-signal gain over the frequency range of 7000 to 10,000 mc.

This all-metal/ceramic tube has been designed for use in high-gain augmenter systems and is rated to meet Class I military specifications. The L-3769 has full performance operation during or after 30-g shock and/or 15-g vibration, as well as at an altitude of 100,000 ft.

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## Shaker Power

A compact 10 kva sine-o-matic electronic power amplifier for driving electro-dynamic shakers in vibration testing systems is being introduced by Ling Electronics Division of Ling-Temco-Vought, Inc.

With standard Ling features of conservative ratings, reserve power, safety interlock system and instantaneous overload protection, the RP-10/16 requires less than 12 sq. ft. of floor space to provide its high power for continuous-duty driving of compatible shakers to full-system performance.

Power output is 10 kva at any load factor from 0.2 leading or lagging to unity, 14 to 3,000 cps. Output voltages decrease proportionally, 14 to 5 cps at rated current, to frequency—which is in the 5-10,000 cps range—with a response of ± db at 5 to 3,000 cps. Full output current is availabel from 5 to 3,000 cps. Plate dissipation is 16 kw continuously.

Circle No. 251 on Subscriber Service Card

## Power Distribution Cable

An ultra-thin multi-layer power distribution cable featuring exactly reproducible electrical characteristics in production has been developed by International Resistance Co.'s plastic products div.

The bonded thermoplastic assembly of the cable has prepositioned taps properly located for connection when the unit is dropped into place—eliminating wiring errors. These Polystrip cables fulfill power distribution requirements in computers, communications and data handling apparatus, switchboards and other complex equipment.

Circle No. 252 on Subscriber Service Card

## Zener Diodes

A line of one-watt subminiature zener diodes is available from TRW Electronics/Pacific Semiconductors, Inc.

The electrical equivalent of types 1N3016B thru 1N3026B, the ±5% series covers the voltage range 6.8v to 18v. PSI designation for the eleven types is PS 10016 thru PS 10026.

The PS 10016 series is the only one-watt zener diode in a subminiature package on the market today. With the exception of 0.030-in. diameter leads, the zeners are physically identical to the half-watt types and are directly interchangeable.

Like the widely used half-watt types, the PSI units exhibit good zener characteristics including sharp knees and freedom from discontinuitis and hysteresis. All units are scope-checked and the line exceeds MIL-S-19500 military requirement.

Circle No. 253 on Subscriber Service Card

THE
NAVY
INSPECTS
SOLID
PROPELLANT
MOTORS
WITH A
VARIAN
RADIOGRAPHIC
LINAC

In December, 1960, a Varian 10 Mev, 500R/min/m radiographic linear accelerator was placed in service at the U.S. Naval Ammunition Depot, Concord, Calif., for radiographic inspection of Polaris missile motors. If your project requires dependable, speedy, high-definition radiography, contact Varian for more information on the many Varian linacs now in service.

VARIAN associates
PALO ALTO 10, CALIFORNIA
Radiation Division

Circle No. 39 on Subscriber Service Card



Little David HICKS and the **GIANTS**

*Remember what happened to the last big guy who gave me trouble?*

Naturally, Little David isn't out to destroy his gigantic competitors. Gosh, we even LIKE some of them.

But Hicks plans to keep on being bright enough and good enough to get OUR SHARE of the missile and rocket business.

We're the only really small fabricator who competes with the Big Boys.

**THERE MUST BE A REASON . . .**

THE HICKS CORP.
SPACE AGE STEEL PRODUCTS
ASHEVILLE, NORTH CAROLINA

Circle No. 44 on Subscriber Service Card


## Servomatic Analyzer

A servomatic analyzer (Model 1990), available from Servo Corp. of America, measures phase, gain, and transient response data to servo systems



at various frequencies. Using this unit, design engineers and production technicians can readily evaluate the behavior pattern of the simplest to the most complex electronic, electrohydraulic, electromechanical, and electropneumatic servo system for ultimate operating conditions.

In addition to generating sine, square, and modulated sine waves, the unit adds triangular wave, modulated triangular wave and modulated square wave configurations as well. Wave configurations are displayed on an oscilloscope with respect to either electronic linear sweep or sinusoidally modulated reference signals. The analyzer can be used to evaluate ac carrier and dc servo systems, accepting any carrier frequency from 50 cps to 10 kc.

Circle No. 254 on Subscriber Service Card

## Oscillator System

Calenco Industries has developed a 1200 Series voltage-controlled oscillator system designed for ground station and laboratory telemetry applications which require wider deviation, higher center frequencies, and better linearity than is normally used. The VCO's can be varied ±65% from center frequency while maintaining good linearity. Linearity is better than 0.1% for ±7½ deviation and proportional for wider deviations. Standard units are available for IRIG channels; other units are available for frequencies up to 800 kc.

The system includes up to ten VCO's, a summing amplifier for a composite output and a power supply module. Each VCO, however, contains a voltage regulator to facilitate operation of individual units from any 20-to-30-volt dc supply.

Circle No. 255 on Subscriber Service Card

## Transistorized Servo Amplifier

A light-weight transistorized servo amplifier which provides 125w zero-degree phase shift output is available from M. Ten Bosch, Inc. The unit is suitable for the operation of two-phase, low-inertial 400-cps motors, gyro torquers, or equivalent equipment.

An overall power gain of 100 db is obtainable in combination with a driver amplifier producing 2w at full signal input. Input impedance is 700 ohms, but this value is nominal and can be varied to suit source requirements. Power requirements are 27v (variable plus or minus 3v) dc at 8.3 amps. maximum line drain.

Circle No. 256 on Subscriber Service Card

## Heat Dissipator

A transistor heat dissipator for TO-18 transistors in circuit-board applications is available from the Thermalloy Co. Designated #2218 series, these two piece units—measuring ⅝-in. diameter by ¼-in. high—will fit all TO-18 cases regardless of case diameter. The dissipators are made of aluminum with three finishes available: #2218—chromate; #2218A—insulated for 400 v breakdown; #2218B—black anodized.

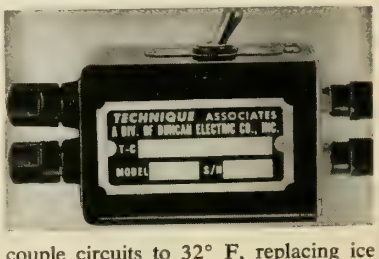
"Positive contact" design provides the optimum heat path from the transistor to the dissipator. Tightening the threaded top firmly grips both sides of the transistor weld flange—point of maximum transistor case temperature. Heat is conducted from the weld flange area to the fins where it is removed by natural convection of forced air cooling. Test reports indicate a transistor junction temperature reduction greater than 50% in still air and up to 85% with forced air cooling.

Circle No. 257 on Subscriber Service Card

## Cold Junction Compensator

Mini-Comp, a single thermocouple cold junction compensator for converting any millivolt potentiometer into an automatically compensated temperature measuring instrument, is available from Technique Associates.

When connected with any potentiometer—recording, controlling, or indicating—the unit references thermo-




couple circuits to 32° F, replacing ice baths and constant temperature chambers. It also connects to the input stages of most dc amplifiers; converts recorder-amplifier combinations into thermocouple-actuated pyrometers. Accuracy is ±½° F when used in ambients from 60° F to 90° F.

Circle No. 258 on Subscriber Service Card

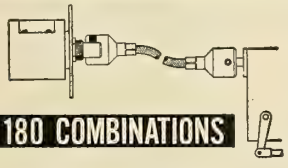
jpl needs

**ELECTRONIC PACKAGING ENGINEERS**

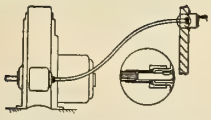
To develop and apply electronic and electromechanical packaging techniques to assemblies for spacecraft. Background in electronic or electromechanical fabrication techniques and knowledge of electromechanical devices. Familiar with preliminary vibration and heat transfer analysis and testing plus general interest in physical sciences. BSME or EE plus 2 years experience minimum.

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**West Coast Plant: 2404 So. Grand Ave., Los Angeles, 7, California**

Circle No. 45 on Subscriber Service Card

## Radiosonde Converter

A data conversion system for weather balloon tracking that uses the latest state-of-the-art digital data techniques to provide continuous information to a battlefield computer is available from DATEX Corp. The Datex CV-772 Radiosonde Data Converter uses a radiosonde, tracking antenna, data converter, field computer, tape punches, and radiosonde recorder.

Atmospheric parameters consisting of temperature, humidity and pressure are measured and recorded. Information for prediction of radioactive fallout patterns is also provided by the system.

Circle No. 259 on Subscriber Service Card

## Tubular Capacitor

A miniature tubular capacitor with weldable leads for cordwood packaging has been introduced by Gulton Industries, Inc. Of a size identical to ¼-watt resistor, the Glenco series CT10D ceramic capacitors are 0.095 in. in diameter by 0.255 in. in length. Their dumet leads are plated with 50u" of gold for maximum weldability.

Capacitance values range from 10 to 1000 MMF in tolerances of +5%, +10%, +20%. The capacitors are rated at 50v dc over a temperature range from −55°C to 150°C. The capacitor exceeds the requirements of military specifications MIL-C-11015B.

Circle No. 260 on Subscriber Service Card

## Miniaturized On/Off Indicator

The Lewis Engineering Co. has available a miniaturized on/off indicator specifically designed for high reliability under severe environmental conditions. The unit has a proved record of reliable operation over temperateures from −67°F and to 158°F. Higher temperatures (257°F) may be obtained for special order variance of this basic-off-the-shelf instrument. The standard units are designed to meet MIL specs for lighting, and for vibration resistance.

Circle No. 261 on Subscriber Service Card

## RF Chokes

Miniature RF Chokes that meet MIL-C-153-5A, Grade 1, Class B specifications are currently available from Nytronics, Inc. These epoxy-encapsulated inductors come in three specific sizes to fit most design requirements: 90 in. long 0.31-in. dia. (inductance values from 1.0 to 10000uH); 70 in. long, 25-in. dia. (inductance values from 1.0 to 1000 uH); and 0.44 in. long 0.188-in. dia. (inductance values from 0.1 to 100 uH). Nytronics' RF chokes have a low dc resistance.

Circle No. 262 on Subscriber Service Card




In January, 1962, a Varian 13 Mev, 2500 R/min/m radiographic linac was placed in service at Thiokol Chemical Corp., Tremonton, Utah. A second similar unit went into operation in August, 1962. If you're looking for speedy, high-definition radiography, contact Varian. Data available on many linacs now in service.

VARIAN associates
PALO ALTO 10, CALIFORNIA
Radiation Division

Circle No. 40 on Subscriber Service Card

## Digitally Controlled Power Supplies

Pioneer Magnetics Inc. is marketing a complete line of digitally controlled power supplies. Available in a single package is a complete static digital-to-



analog converter and precision power supply whose output can be automatically set to any desired level from zero to full voltage by means of a digitally coded input signal.

The supplies are designed to receive a parallel binary 10-bit input. The input logic levels are zero volts true, and 6 volts false, with other logic levels available on request. Accuracy of the output is well within 10 millivolts of the output level demanded by the input signal. These accuracies are maintained regardless of load and supply line variations.

Circle No. 263 on Subscriber Service Card

## Resolver Index Stand

Kearfott Div., General Precision Aerospace has produced an environmental index stand designed for rapid testing of synchros and resolvers in temperatures ranging from −55° C to 125° C. It incorporates provision for vertical mounting in high or low temperature or humidity chambers, and can be used to test either conventional case or gimbal-mounted components. Index accuracy is ±10 sec. of arc at 20° C and ±18 sec. of arc from −55° C to 105°. Index increments are every 5° from 0° to 360°. Adapters can be used from size 5 to 37.

Circle No. 264 on Subscriber Service Card

## Miniature VHF Transmitter

A miniature VHF transmitter capable of developing 20 watts of power with only two transistors in the final stage is being marketed by Sylvania Electric Products, Inc.

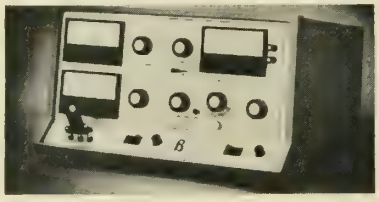
The unit, about the size of a cigar box, is designed to replace bulky airborne or vehicle-mounted units and marks a new level of capability in the solid-state field.

Circle No. 265 on Subscriber Service Card

## Semiconductor Test Set

The lightweight Model 70 portable semiconductor test set, using the plug-in module concept that permits one basic set and any combination of modules to perform multi-parameter tests, is being marketed by the Birtcher Corp. This plug-in module concept precludes obsolescence because new modules will be made available to meet the latest parameter and test requirements presented by new semiconductor developments.

The basic unit contains power sup-



plies and metering circuitry for setting up bias conditions on semiconductors. It features automatic and re-settable overload protection with meter accuracy of 1%.

Circle No. 266 on Subscriber Service Card

## Shielded Transformers

James Electronics, Inc., has developed manufacturing techniques for achieving a high degree of electrostatic and magnetic shielding in their A-7100 series precision instrument transformers.

Standard models are available with up to 160 db of common mode rejection. Magnetic shielding of up to 120 db can be achieved with the packages and hum-bucking features. James Electronics incorporates 0.05% resistance balance or better between precision windings.

Circle No. 267 on Subscriber Service Card

## FM Discriminator

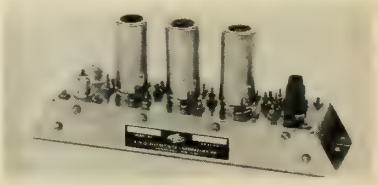
Data-Control Systems, Inc. has available Model GFD-3 subcarrier discriminators, as well as associated tuning units and low pass filters. The FM discriminator is of a solid-state, phase-locked-loop type and is designed for accurate data acquisition and playback in laboratories, test sites and other data control facilities. Input frequency range is from 300 cps to 300 kc and deviations from ±4.7% to 40%, using plug-in filter and tuning units. The appropriate filter unit snaps into the desired frequency tuning unit, which is inserted into the front panel of the discriminator, and locked in place with a one-motion locking device.

Circle No. 268 on Subscriber Service Card

## Preamplifier Series

Low noise, wide bandwidth, gains of 40 db minimum and rugged construction are features of the preamplifier series available from RHG Electronics Laboratory, Inc.

Standard units are centered at 30 and 60 mc with noise figures of 2.0 and 3.5



db, respectively. Bandwidth is 10 mc at 1 db down. Gain is 40 db minimum with 50 db typical. Balanced and unbalanced inputs are available for any type of crystal mixer.

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**Lon D. Barton, *President***

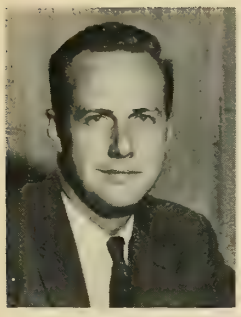
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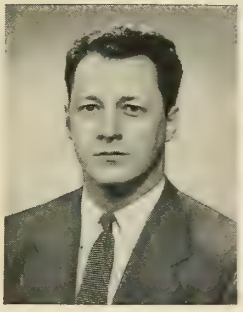
# names in the news



MORRISON



STEEVES



FRIES

**John W. Morrison:** Appointed general manager of the West Coast operations of Minneapolis-Honeywell's Ordnance Div., Duarte, Calif.

**Philip H. Williams:** Named research manager of Astrosonics, Inc., Syosset, N.Y.

**Donald J. Hawthorne:** Elected chairman of the board of directors and chief executive officer of General Time Corp., New York City. **B. K. Wickstrum** elected president and **Don G. Mitchell** elected chairman of the executive committee.

**A. V. Pilling:** Elected vice president of Hayes International Corp., Birmingham, Ala.

**Dr. Seymour Lampert:** Named manager of advanced systems research at North American Aviation's Space and Information Systems Div., Downey, Calif.

**Dr. Charles F. Gell:** Manager of life sciences for Ling-Temco-Vought's Vought Astronautics Div., Dallas, Tex., named first president of the new Aerospace Industrial Life Sciences Assn.

**Robert E. Dunaway:** Appointed senior scientist in the Dept. of Experimental Physics, MHD Research, Inc., Newport Beach, Calif.

**George W. Steeves:** Named director of the Industrial Div., Radio Shack Corp., Boston, Mass.

**L. Frank Robinson, Jr.:** Appointed manager of quality control at General Electric's Electronic Specialty Capacitor Operation, Irmo, S.C.

**James H. Fessler:** Formerly with International Rectifier, joined National Transistor Mfg. Co., Lawrence, Mass., as field sales engineer.

**Alfred M. Mayo:** Formerly with NASA, joined Ling-Temco-Vought, Inc., as manager of the Advanced Systems Dept. of Chance Vought Corp.'s Astronautics Div., Dallas, Tex.

**Francis V. Wagner:** Appointed director of plans and programs of Informatics, Inc., Culver City, Calif.

**Willard Fazar:** Elected vice president for operations research and systems engineering of Herner & Co., Washington, D.C. **William A. Creager** elected vice president for information programs.

**Robert C. Lewis:** Appointed general manager of Endevco Corp.'s Dynamic and D. C. Instruments Divs., Pasadena, Calif.

**Capt. Kenneth Gentry (USN ret.):** Named assistant to the general manager, Chicago center, Motorola Military Electronics Div., Motorola, Inc., Chicago.

**Walter G. Olson:** Elected to the board of directors of Eitel-McCullough, Inc., San Carlos, Calif.

**Col. Richard M. Baker (USMC ret.):** Joined E. W. Bliss Co.'s Aircraft Launching and Recovery Equipment Div., Drexel Hill, Pa., as technical liaison representative.

**James E. McLeod:** Appointed director of engineering at Page Communications Engineers, Inc., Washington, D.C.

**Dr. William Firestone:** Appointed assistant general manager for research and development engineering, Military Electronics Div., Motorola, Inc., Chicago.

**Robert W. Mallory:** Named manager of the mechanical engineering department of Rantec Corp., Calabasas, Calif.

**Theodore F. DeBauw:** Named director of quality and reliability assurance at Lockheed Propulsion Co., Redlands, Calif.

**Raymond S. Fries:** Appointed general manager of Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

**Martin W. Joseph:** Named reliability manager for the Industrial Group of Elgin National Watch Co., Elgin, Ill.

**George H. Jeffs:** Named manager of the newly formed Paraglider program at North American Aviation's Space and Information Systems Div., Downey, Calif.

**Robert F. Tucker (USN ret.):** Joined the engineering staff of Electronic Systems Div., Antenna Systems, Inc., Maitland, Fla.

**Bill M. Lane:** Named new projects manager of Vitro Service Div., Vitro Corp. of America, Fort Walton Beach, Fla.

**Dr. John R. Summerfield:** Appointed corporate staff economist at Douglas Aircraft Co., Santa Monica, Calif.





In January, 1962, a Varian 10 Mev, 500R/min/m radiographic linear accelerator was placed in service for the Douglas Aircraft Company at Elgin AFB, Florida. If your activity demands rapid, dependable high-definition radiographic inspection, contact Varian for more data on the many Varian linacs now in service.

VARIAN associates

PALO ALTO 10, CALIFORNIA
Radiation Division




Circle No. 41 on Subscriber Service Card

# contracts and procurements

## AWARDS

### AIR FORCE

$22,800,000—**Aerospace Corp.,** El Segundo, Calif., for systems engineering and technical direction of ballistic missile and space programs, management services and administrative support (supplemental contract).

$15,150,000—**Martin Marietta Corp.,** Baltimore, Md., for research and development of the *Titan II* weapon system (supplemental contract).

$15,000,000—**Federal Electric Corp.,** Paramus, N.J., for operation, maintenance and support of Distant Early Warning System.

$10,800,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for long lead time items and ground support equipment for *Skybolt* missiles (supplemental contract).

$4,001,000—**The Mitre Corp.,** Bedford, Mass., for systems engineering and technical development of command and control systems (supplemental contract).

$3,914,000—**Paul Hardemann, Inc.,** Stanton, Calif., for installation and checkout of propellant transfer systems at Vandenberg, Davis-Monthan, McConnell and Little Rock Air Force Bases (supplemental contract).

$2,450,000—**Martin Marietta Corp.,** New York, for umbilical installation and testing for *Titan I* missile site activation at Ellsworth, Mountain Home, Larson and Beale Air Force Bases (supplemental contract).

$2,175,000—**Martin Marietta Corp.,** Baltimore, Md., for follow-on production of *Titan I* missile and associated equipment (supplemental contract).

$2,000,000—**American Machine and Foundry Co.,** New York City, for work on *Titan I* launcher systems at Ellsworth, Mountain Home, Larson and Beale Air Force Bases (supplemental contract).

$1,900,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for space vehicles (supplemental contract). Work to be done at Sunnyvale, Calif.

$1,500,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for research and development work on space systems (supplemental contract). Work to be done at Sunnyvale, Calif.

$1,391,288—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space vehicles.

$1,280,000—**North American Aviation, Inc.,** Downey, Calif., for spare parts to support the *Minuteman* guidance control system.

$1,215,800—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space vehicles. Work to be done at Sunnyvale, Calif.

$1,212,121—**Martin Marietta Corp.,** New York City, for spares and related equipment for the *Titan I* weapon system (supplemental contract). Work to be done at Denver, Colo.

$1,200,000—**Radio Corp. of America, Electronic Products Div.,** Moorestown, N.J., for final stage vehicles and services in support of space programs (supplemental contract).

$1,197,000—**Aerojet-General Corp.,** Azusa, Calif., for research and development on Stage II *Minuteman* motors. Work to be done at Sacramento, Calif.

$61,178—**Hughes Aircraft Co.,** Culver City, Calif., for modification of MA-1 *Crazy Nose* stands compatible with interceptor improvement program changes to the MA-1 system and for providing check-out assistance for Phase 2 *Crazy Nose*.

**Bendix Radio Div.,** Baltimore, Md., for study, investigation and development of ultra-reliable, micro-miniaturized advanced design techniques for super-high-frequency communications equipment for future space vehicles (undisclosed amount).

### ARMY

$4,900,000—**Bell Aerosystems Co.,** Buffalo, N.Y., for a radio command control system for the SD-1 drone.

$4,900,000—**Sperry Gyroscope Co.,** Great Neck, N.Y., for work on the *Nike-Zeus* missile (supplemental contract).

$2,700,000—**Ford Motor Co.'s Aeronutronic Div.,** Newport Beach, Calif., for continued development of the *Shillelagh* missile system.

$1,269,117 — **Consteel-Ets-Hokin-Galvan,** Cocoa Beach, Fla., for alterations to launch and additions to fueling systems at Cape Canaveral.

$356,000—**The Bendix Radio Div.,** Towson, Md., for syncom ground communications modification equipment.

$117,000—**Lionel Corp., Telerad Div.,** Flemington, N.J., for production of 100 Beacon "C" bands to be used at White Sands Missile Range, N.M.

$41,500—**Electronic Systems-East Div., Sylvania Electric Products, Inc.,** Waltham, Mass., for tracking receiver modifications.

### NAVY

$40,000,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for work on *Polaris* missiles (2 contracts).

$4,679,108—**Martin Marietta Corp.,** Orlando, Fla., for additional *Bullpup* missiles.

$3,100,000—**Sperry Gyroscope Corp.,** Great Neck, N.Y., for 14 advanced-design checkout consoles for use in *Polaris* submarine navigation systems.

$2,421,918—**Raytheon Co.,** Sudbury, Mass., for electronic equipment for the *Polaris* missile guidance system.

$2,000,000—**Radio Corp. of America, Defense Electronic Products,** Moorestown, N.J., for missile precision on instrumentation radar.

$1,400,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for *Polaris* test vehicles.

### NASA

$771,715—**Marbury-Pattillo Construction Co.,** Birmingham, Ala., for substructure and utilities at Building 4619, Marshall Space Flight Center, Huntsville, Ala.

$88,000—**Beckman Instruments, Inc.,** Fullerton, Calif., for design and construction of a miniaturized carbon-dioxide warning system for Project *Mercury* spacecraft.

$75,000—**Radiation, Inc.,** Melbourne, Fla., for improving pulse code modulated telemetry signals.

$68,046—**Hughes Research Laboratories,** Malibu, Calif., for studies of multiple access satellite communication.

### INDUSTRY

$4,900,000—**Sperry Gyroscope Co., Surface Armament Div.,** Great Neck, N.Y., from **Bell Telephone Laboratories,** for additional target track radar transmitters for the *Nike-Zeus* system.

$400,000—**Radiation, Inc.,** Melbourne, Fla., from **AC Spark Plug,** for providing additional pulse code modulation (PCM) telemetry systems for the *Titan* program.

$350,000—**California Resistor Corp.,** Santa Monica, Calif., from **Boeing Co.,** for wire-wound resistors for the *Minuteman* weapon system.

$200,000—**PneumoDynamics Corp. of Cleveland,** from **Boeing Co.,** for design, manufacture and test proving a shock insulation system for the *Minuteman* missile.

**Air Borne Controls, Inc.,** Sun Valley, Calif., from **Space Technology Laboratories, Inc.,** for provision, design finalization, mock-up, tooling and production fabrication of satellite internal electronic harnessing for the *Orbiting Geophysical Observatory* (undisclosed amount).

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

Negotiations will be conducted with Minneapolis-Honeywell Regulator Co., Aeronautical Div., Minneapolis, Minn., for adaptive flight controller performance evaluation with a time-varying simulation of *Titan II*. This is a continuation of Contract AF 33(616)-8425—RFP-ASD-161205-RKNB. Note: for information only. RFP not avaialble.

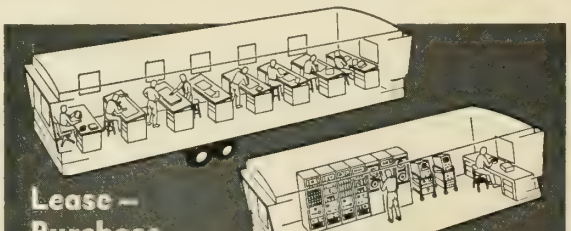
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National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.

Negotiations will be conducted with Dr. Sem-


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# contracts and procurements

Jacobson, Rochester, Minn., for a sub miniature transistor EEG amplifier VESLA—RFP 63-196P. Note: for information only. RFP not available.

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National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Solid-state phase lock telemetry receiver, in quantities of one, two or three. One or two WKWL or three solid-state phase lock telemetry receiver (SWLM)—RFP 18211—RFP due date 9-27-62. Invited to participate: Vitro Corp. of America, Vitro Eelctronics Div., 919 Jesup-Blair Dr., Silver Spring, Md.; Resdel Engineering Corp., 330 S. Fair Oaks Ave., Pasadena, Calif; Defense Electronics, Inc., 5481 Randolph Rd., Rockville, Md.; General Electric Lab., Inc., 8521 Second Avenue, Silver Spring, Md.; Applied Technology, Inc., Leap Indian Trail Ave., Palo Alto, Calif.; Thompson Ramo Wooldridge, Ramo Wooldridge Div., 8433 Fallbrook Ave., Canoga Park, Calif., Attn: Mr. E. A. Pointer; Litton Systems, Inc., Maryland Div., 5009 Calvert Rd., College Park, Md.,; International Telephone and Telegraph Corp., ITT Federal Lab., 500 Washington Ave., Nutley 10, N. J.; Avco Corp., Electronics & Ordnance Div., 2630 Glendale-Milford Rd., Cincinnati 15, Ohio; Lear Siegler, Inc. (formerly Hallamore Electronics), 714 N. Brookhurst St., Anaheim, Calif.; Cutler-Hammer, Inc., Airborne Instruments Lab., Deer Park, N.Y., Attn: H. M. Stephey; Motorola Communications & Electronics, Inc., 4501 W. Augusta Blvd., Chicago, Ill.; Pickard & Burns, Inc., 240 Highland Ave., Needham, Mass.; Space General Corp., 777 Flower St., Glendale 1, Calif.; American Electronic Lab. (Amelco), 1625 E. 126th St., Hawthorne, Cailf.

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Bureau of Naval Weapons
Washington, D.C.

BuWeps contemplates award of a contract to the Martin Marietta Corp., Orlando, Fla., to furnish 1022 "S" type launchers. This notice is made solely to inform potential subcontractors of proposed procurement. RFP is not available. Small business firms and others interested in subcontracting should contact the above firm. Direct referencing CN 6634-62, BuWeps synopsis No. 51-63.

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Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Services and materials necessary for designing, fabricating, instrumenting, measuring and reporting on physical properties, and delivering FOB Hampton, Va., one wind-tunnel model of a *Saturn SA-5* vehicle and associated umbilical tower—to meet requirements of NASA Specification L-2654, dated August 31, 1962—and related drawings. Bids are requested on a fixed-price basis—one each—IFB L-2654—Bid Opening 10-1-62.

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Bureau of Naval Weapons
Washington, D.C.

The Bureau proposes to negotiate with Royal Jet Industries, Inc., 1035 Westminster Ave., Alhambra, Calif., for an additional quantity of *Sparrow III* shipping containers—as this company is considered to be the only current producer capable of meeting an urgent, short deadline for deliveries beginning in October and concluding in November 62. Only by tying this requirement to an existing production line can the delivery schedule be met. Firms interested in subcontracting should contact the above firm. Direct referencing CN0942-63. RFP is not available. BuWeps synopsis No. 55-63.

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U.S. Navy Dept.
Bureau of Ships
Washington 25, D.C.

The Bureau of Ships under RFP 405-30422(S) is soliciting a proposal from Maryland Shipbuilding and Drydock Co., Baltimore, Md., and Bethlehem Steel Corp., Baltimore, Md., for conversion of AVM-1 to a *Typhon* weapon system evaluation ship. One of the major equipments of such system is the AN/SPG-59 radar being constructed at Baltimore. Firms considered for this work must be located in Baltimore, as it is not feasible to move this radar outside the Baltimore area. Small business firms or others interested in subcontracting opportunities in connection with this procurement are advised make direct contact with the above firms. Prior security clearance will be required by partcipating firms.

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National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Md.

Provide non-personnel services for operation and maintenance of automated satellite telemetry data processing system. NASA Procurement Office at GSFC has issued invitations for bids No. PCM-28784 for the furnishing of labor, materials, equipment and services to operate and maintain the number of lines of automated satellite telemetry data processing equipment. Bids are due at Goddard Space Flight Center, Greenbelt, Md., Code 241.5, Attn: Mr. W. E. Doles, before 3:00 PM, EDST, 9-20-62.

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National Aeronautics and Space Administration
Manned Spacecraft Center
Apollo Procurement Office
Houston 1, Tex.

2295/2115 MC transponder—one each—RFP MSC 63-198P—RFP due date 9-26-62.

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Directorate, Procurement and Production
Middletown Air Materiel Area
Olmsted Air Force Base, Pa.

Contract technical services for CNI(ASQ-19) airborne digital communications systems, SM-65 missile microwave, TSC-15 communications central. Collins SSB radio equipment AN/ARN-14 Omni-VOR radio for aircraft C-140A by eleven tech reps for 95-man-months. Negotiations will be conducted with Collins Radio Co., 321 Third St., S. E., Cedar Rapids, Iowa. This is a continuation of contract AF 36(600)-10635. Inquiries must refer to RFP MA-4023-5 & 6-PDC. Note: for information only. No RFP available.

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Secondary Items Branch
Procurement Div.
Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

M30 rocket motor and adapter assembly with container—260 each w/option quantity 130 each—Ord. part No. 8030881 and 8034427—gas generator assembly Ord. part No. 8030880—7 each w/option quantity 2 each—IFB IXXF ORD-01-021-63-10069B. Bid opening 10-16-62. Drawings and bid sets available from nearest Ord. Dist. An additional quantity of 260 each M30 rocket motor and adapter assembly is being reserved for labor surplus areas.

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National Aeronautics and Space Administration
Apollo Procurement Office
Houston 1, Texas

Negotiations will be conducted with Emerson Electric Mfg. Co. for performance evaluation of thermolag material for entry heat protection of advanced manned spacecraft—RFP MSC-63-250P. Note: For information only. RFP not available.

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Purchasing Office
Range Procurement Division (MTDRC-4)
Air Force Missile Test Center
Patrick Air Force Base, Fla.

Time division multiplex station type I, 11 each; time division multiplex station type III, one each; time division multiplex station type I and III, five each; initial spare parts, parts list, instruction books and other support items. Deliveries to be furnished at a later date. Procurement will be accomplished in two phases: submission and evaluation of technical proposals without pricing to determine acceptabiilty of supplies and services offered; after evaluation of technical proposals, invitations for bids issued only to those firms having technically acceptable proposals. Letter request for technical proposal No. 63-1079. Due date for technical proposal 10-8-62. Complete data not available. Available specifications, plans or drawings relating to the procurement described above do not fully provide all necessary manufacturing and construction details.





In May, 1962, a Varian 10 Mev, 500 R/min/m radiographic linear accelerator became operational at Aerojet-General's facility in Sacramento, California. A second similar unit was placed in service in August, 1962. If your project calls for fast, dependable, high-resolution inspection, contact Varian for more data on the many linacs now in service.

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## SEPTEMBER

**Air Force Association's Sixteenth National Convention and Aerospace Panorama,** Nellis Air Force Base Gunnery Range, Las Vegas, Nev., Sept. 18-23.

**Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences,** Hotel Commodore, New York City, Sept. 19-20.

**Eleventh Annual Industrial Electronics Symposium, sponsored by IRE, American Institute of Electrical Engineers and Instrument Society of America,** Sheraton Hotel, Chicago, Sept. 19-20.

**IRE Conference on Communications,** Roosevelt Hotel, Cedar Rapids, Iowa, Sept. 21-22.

**National Power Conference, (ASMW-AIEE),** Lord Baltimore Hotel, Baltimore, Md., Sept. 24-26.

**Thirteenth International Astronautical Congress, American Rocket Society,** Sofia, Bulgaria, Sept. 24-28.

**Space Power Systems Conference, American Rocket Society,** Miramar Hotel, Santa Monica, Calif., Sept. 25-28.

**Symposium on the Physics of Failure in Electronics, sponsored by Rome Air Force Development Center, USAF Systems Command and Armour Research Foundation,** Illinois Institute of Technology, Chicago, Sept. 26-27.

**Symposium on Dynamic Behavior of Materials, sponsored by the University of New Mexico and Rocky Mt. district of American Society for Testing and Materials,** Statler Hilton Hotel, Los Angeles, Sept. 30-Oct. 5.

**Third Annual Aerospace Fair,** Vandenberg Air Force Base, Calif., 10 a.m. to 4 p.m., Sept. 30. (Open to the public.)

## OCTOBER

**National Communications Symposium, Institute of Radio Engineers,** Hotel Utica, Utica, N.Y., Oct. 1-3.

**Third Symposium on Advanced Propulsion Concepts, sponsored by General Electric Co. and AFOSR,** Sheraton Gibson Hotel, Cincinnati, Ohio, Oct. 2-4.

**National Symposium on Space Electronics and Telemetry, IRE,** Fountainebleau Hotel, Miami Beach, Fla., Oct. 2-4.

**Tenth Annual Human Engineering Institute, sponsored by Dunlop & Associates,** Stamford, Conn., Oct. 2-5.

**Eighteenth Annual National Electronics Conference and Exhibition, sponsored by AIE, IRE, Illinois Institute of Technology, Northwestern University and University of Illinois,** McCormick Place, Chicago, Ill., Oct. 8-10.

**Conference on Ions in Flames and Rocket Exhaust,** El Mirador Hotel, Palm Springs, Calif., Oct. 10-12.

**Twentieth Annual Aerospace Electronics Exposition/Report, Aerospace Electrical Society,** Pan Pacific Auditorium, Los Angeles, Calif., Oct. 10-12.

**Symposium on Photography of Electronic Display,** Shoreham Hotel, Washington, D.C., Oct. 12-13.

**International Symposium on Space Phenomena and Measurement, sponsored by NASA and AEC,** Statler Hilton Hotel, Detroit, Mich., Oct. 15-18.

**Instrument Society of America's Seventeenth Annual Instrument-Automation Conference & Exhibit,** New York City, Oct. 15-17.

**Magnesium Association Annual Convention, Biltmore Hotel,** Los Angeles, Calif., Oct. 15-17.

**Ninth Annual Joint ASME-ASLE Lubrication Conference,** Hilton Hotel, Pittsburgh, Pa., Oct. 16-18.

**Fifteenth Pacific Coast Regional Meeting, American Ceramic Society,** Olympic Hotel, Seattle, Wash., Oct. 17-19.

**Electronic Industries Association Meeting,** Seattle, Wash., Oct. 17-21.

**Ninth Annual East Coast Conference on Aerospace and Navigational Electronics,** Emerson Hotel, Baltimore, Md., Oct. 22-24.

**1962 Computer Applications Symposium, sponsored by Armour Research Foundation of the Illinois Institute of Technology,** Morrison Hotel, Chicago, Ill., Oct. 24-25.

**Seventeenth Midwest Quality Control Conference, American Society for Quality Control,** Denver Hilton Hotel, Denver, Colo., Oct. 26-27.

**American Society of Safety Engineers First Technical Conference,** Morrison Hotel, Chicago, Ill., Oct. 29.

**Meeting on Large Rockets, IAS,** El Dorado Inn, Sacramento, Calif., Oct. 29-30.


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# A Plea for Simplicity

THE PROBLEMS OF the space electronics field might be summed up in the following Request for Proposal:

> Govt. agency wants multi-purpose, easily maintained, extremely reliable, long life, radiation-immune, interference-free micro-miniaturized system, capable of operating at all temperature and humidity ranges. Must be low cost.

This mythical RFP may seem facetious at first glance. But it summarizes the demands placed today on the electronics engineer and manufacturer by the National Aeronautics and Space Administration and the Dept. of Defense.

The problems in space electronics are varied:

• What weight should a company assign to each of the requirements? How far does DOD really want to go in microminiaturization? How much will NASA pay for the reliability it demands? The need to pour company money into a program to meet today's extremely high reliability requirements is offset by the knowledge that, when the chips are down, the procurement officer may take the expedient route by buying the cheapest item available.

• NASA and DOD space electronics procurement currently is a low-volume, extra-high-reliability market. At the same time, the two agencies are pushing standardization of both components and circuits. This anomaly can be self-defeating, particularly if pursuit of standardization defeats technical advances growing out of the headlong pace of electronics research and development.

• With increasing complexity, ease of maintenance is declining. A new philosophical approach is needed.

• With NASA the greatest beneficiary of microminiaturization in space electronics, it is doing the least to support this development area. The space agency, in effect, still is reaping the benefit of Air Force investment. How long this momentum can continue without NASA support is questionable.

The above essentially are management problems which must be met both by government and industry. Technical problems in space electronics are equally numerous. To name only two:

• Radiation effects on space components are far from apparent. Firms such as IBM, General Electric, and RCA are carrying on company-funded investigation of radiation effects. This is of little immediate benefit to the small companies that contribute so much to electronics development. Yet there is no large government-funded effort in this vital field.

• Interference problems created by the innumerable radio frequency emitters are troublesome and growing worse as the space program expands. The Electromagnetic Compatibility Analysis Center, operated by Armour Research Foundation for Air Force Systems Command, is just beginning involved studies into spectrum signatures and listings of all military transmitters. This effort initially is concentrating on military radar systems with communications problems shelved for the time being.

It is, however, an effort that must be expanded. The great concern for component reliability is not being matched by efforts directed toward overall reliability under RFI.

These technical and management problems plaguing the space electronics field can be met on a piecemeal basis. But there is one overall problem which must be tackled on a broad front.

It has been labeled by one of DOD's top scientists as the American Syndrome. This is described as a confusion of gadgetry with progress, increasing complexity with improvement and more complex instrumentation with new invention.

ASSISTANT AIR FORCE Secretary (R&D) Brockway McMillan, outlining the ravages of the disease, describes a military communication relay center he recently visited:

Very elaborate antennas of intricate design unfortunately screened each other. Simple antennas occupying less space would have had less screening and the net output would have been equivalent at a much lower cost.

Inside the station were racks of all types of receivers, neatly stacked in rows. The floors were of the highest grade tile and were polished to a high gloss. The operators' consoles were thoroughly human-engineered. There were hundreds of buttons and a neatly-centered oscilloscope display. The operator could switch any receiver to any transmitter and could connect any channel to any of a series of tape recorders. Since the traffic could be CW or voice or multiplex or high-speed data, the receiver had different bandwidths and the recorders also had a wide variety of bandwidths. Wiring for the modular construction was extremely complicated to make test points readily accessible to maintenance personnel.

Outstanding feature of the installation was the deluxe maintenance console. All important inputs and outputs were brought to this console. It sparkled with myriads of switches, oscilloscopes and pilot lights.

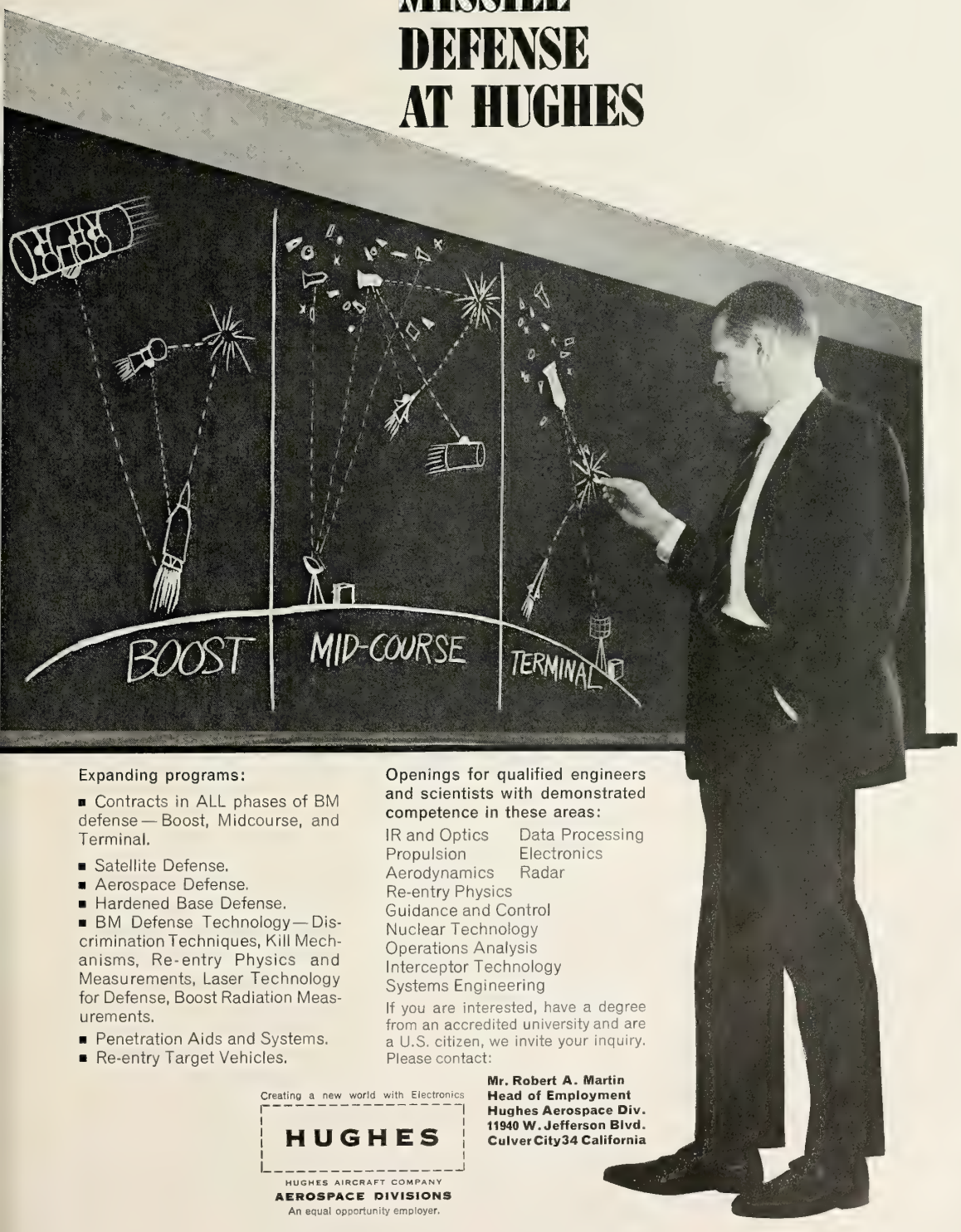
There were hoards of contractor personnel in the station. What were they doing? Trying to make the maintenance console work!

"That deluxe radio relay station is in a constant state of repair, rather than in service," McMillan points out.

To prevent this, the American Syndrome—with its pursuit of complexity for complexity's sake—must be eradicated by a joint effort of government and industry. Solution of the other problems then will come more easily and more quickly— for the true fulfillment which today is only the promise of space electronics.

**William J. Coughlin**

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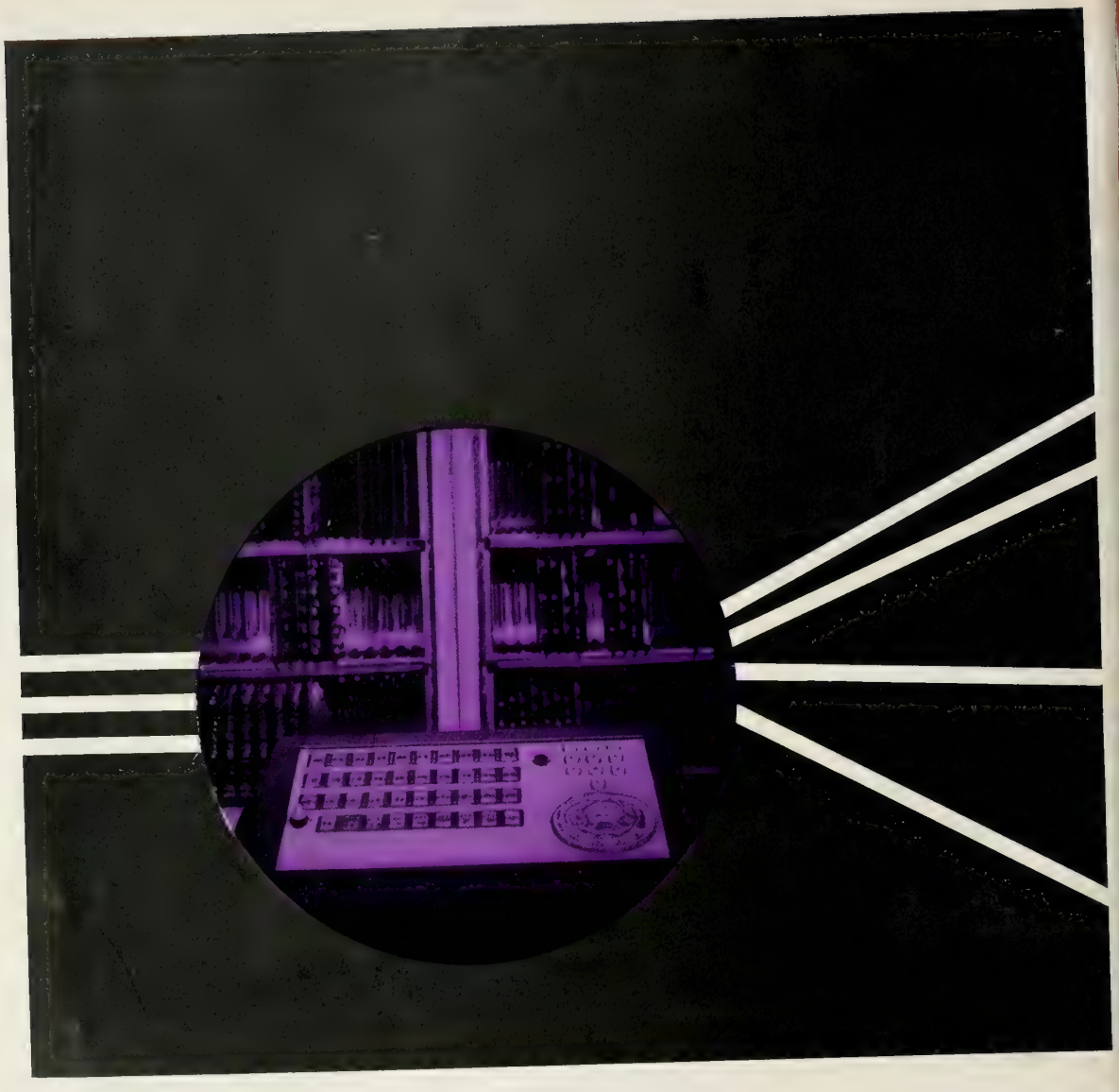
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# missiles and rockets

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## Details Of $7-Billion '64 Space Budget

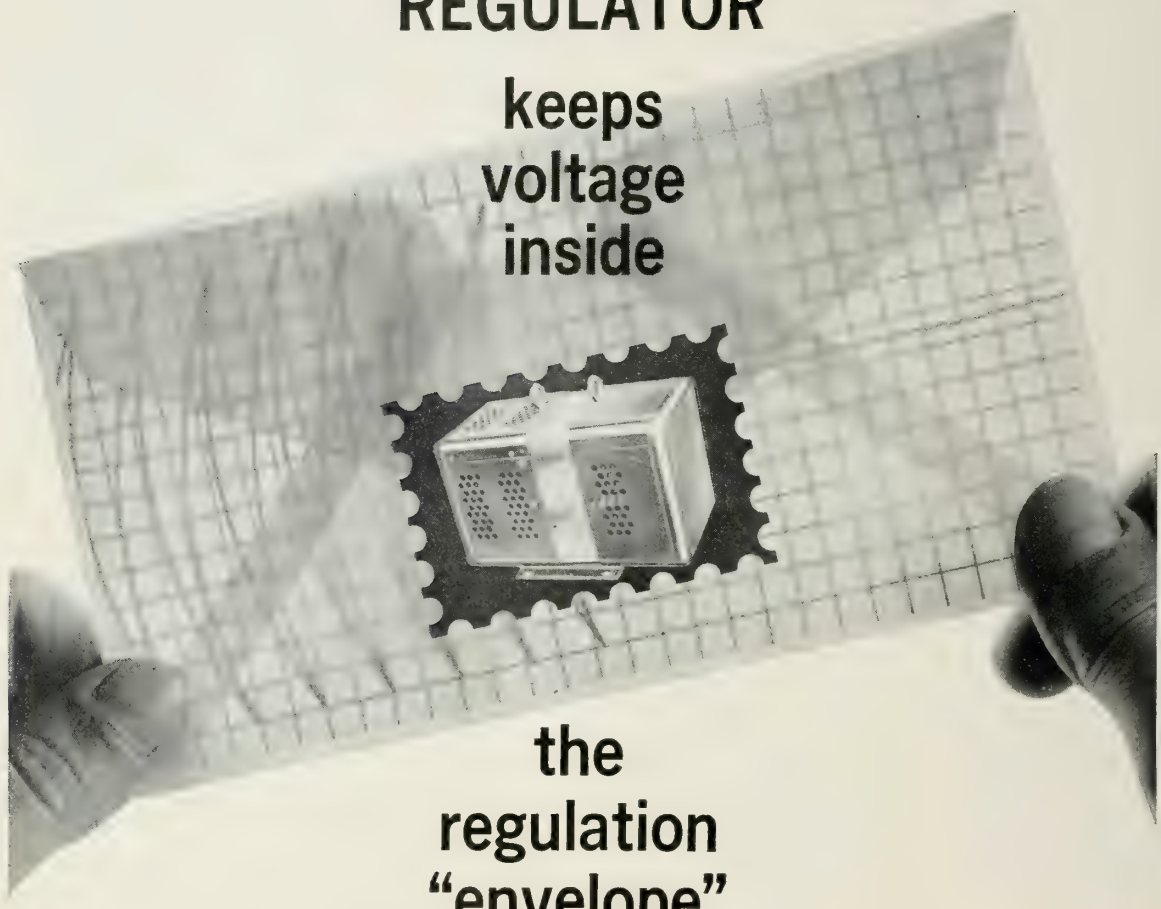
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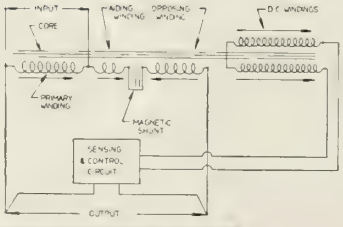
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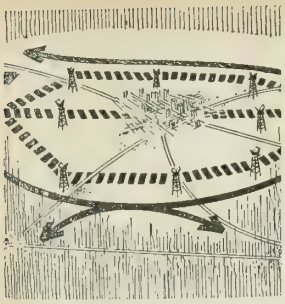
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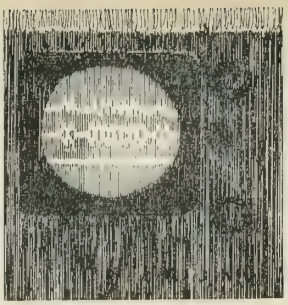
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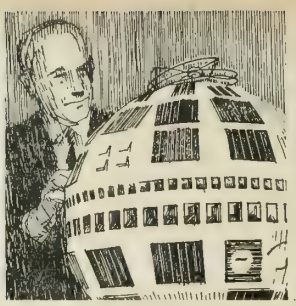
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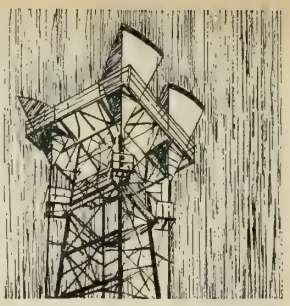
Bypass routes



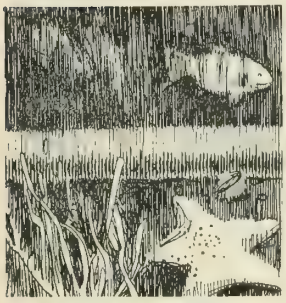
Digital transmission



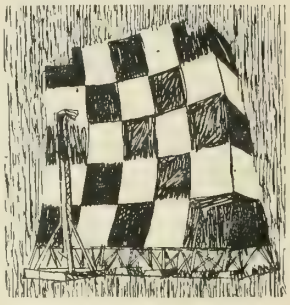
Communications satellites



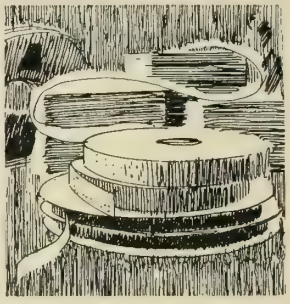
Microwave transmission



Submarine cable



Tropospheric scatter



Data communications

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 13 September 24, 1962

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## THE COVER



*Top to bottom: Bullpup B, Bullpup B/GAM 83A, GAM 83B (first photo) and T-GAM 83. GAM 83B's stages are: 1st, guidance; 2nd, nuclear arming; 3rd, nuclear payload and 4th, propulsion unit.*

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†U.S. Reg. Pdg.

*43,223 copies this issue*



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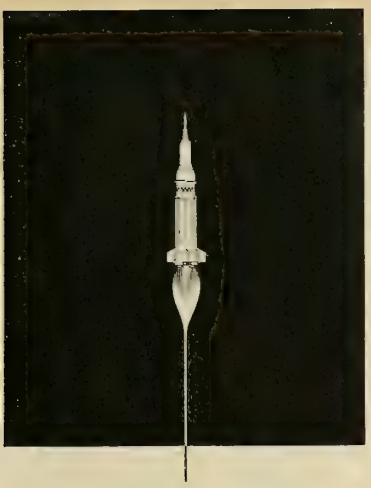
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# letters

## 'The Big Knife'

*To the Editor:*

Bouquets are in order for your "The Big Knife" editorial (M/R, Aug. 20). There is an additional immediate-action item which I feel should be added. This concerns adjusting or freeing the system of checks and balances that makes our governmental processes democratic. Since it is so basic, it is very touchy in its implementation, but a solution must exist.

Presently our Defense Department is under very close scrutiny in decision-making matters. The pressures by the Congress—the public—are so severe that it takes a very courageous man to make a decision involving the dispensing of the large amounts of money called for. The result is the requirement of additional time—delaying study programs running 'way beyond the planned contract award date—and the use of fiscal-year funding techniques under which the defense contractor must negotiate and rejustify his plans every year. This procedure leaves the contractor "holding the bag" while his contract is awaiting decision for renewal under conditions of considerable doubt and uneasiness as to the terms of go-ahead he will receive. Maintaining a specialized *team* of program personnel under conditions of questionable spurt-by-spurt funding is almost impossible and is rough on program morale.

A solution is not proposed herein, but certainly a technique of giving our leadership a freer hand, less suspicion and more confident backing is necessary. Giving the decision-maker an acknowledged tolerance or regime within which he can operate would speed results. This trust is necessary, and has been given to the President through our elective processes; it should be extended in some manner to our Defense Department, with fewer strings attached. Decisions, whether correct or in error, do represent progress.

I believe you will find that this item is fundamental to motivating the first six items that you listed in the editorial.

A. M. Arnold
Mercer Island, Wash.

## Propulsion Puzzle

*To the Editor:*

I am confident that many people have given serious thought toward an appraisal of our space effort, as you have done from time to time in M/R and most recently in your editorial of Aug. 27 ("Playing with Blocks," p. 58). The critical question of how we are doing is one of natural concern to all.

For most of us, it is a difficult question to answer, and probably only a few people are in a position to even make an attempt, but some reflections on that subject by workers in the field would not seem completely amiss.

I can only speak unofficially from my area of propulsion, which, benefiting from a good start relative to other disciplines such as guidance, has made progress that I never thought I would have the satisfaction of witnessing. But equally surprising to me is the observation that the progress was made without the necessity of great scientific breakthroughs—just the application of a large amount of work by hard-working people.

Of some significance, it would seem, is that new propulsion steps in the direction of increased thrusts (a much-publicized subject), increased thrust without increase in powerplant size and thrust from nuclear energy, can still be achieved from the same formula, but now after two decades of experience.

In light of that potential and a record of achievement, it is difficult to understand how we are in a position other than the one we want to be in, at least from the standpoint of propulsion.

John P. Sellers, Jr.
Woodland Hills, Calif.

## Boosting Solids

*To the Editor:*

Your editorial "Playing with Blocks" (M/R Aug. 27, p. 58) is another characteristically factual commentary which is well taken and overwhelmingly approved. I think you recognize (if NASA and DOD do not) the urgent importance of large solid booster development, as you have continually expressed concern over lagging support for the solid system.

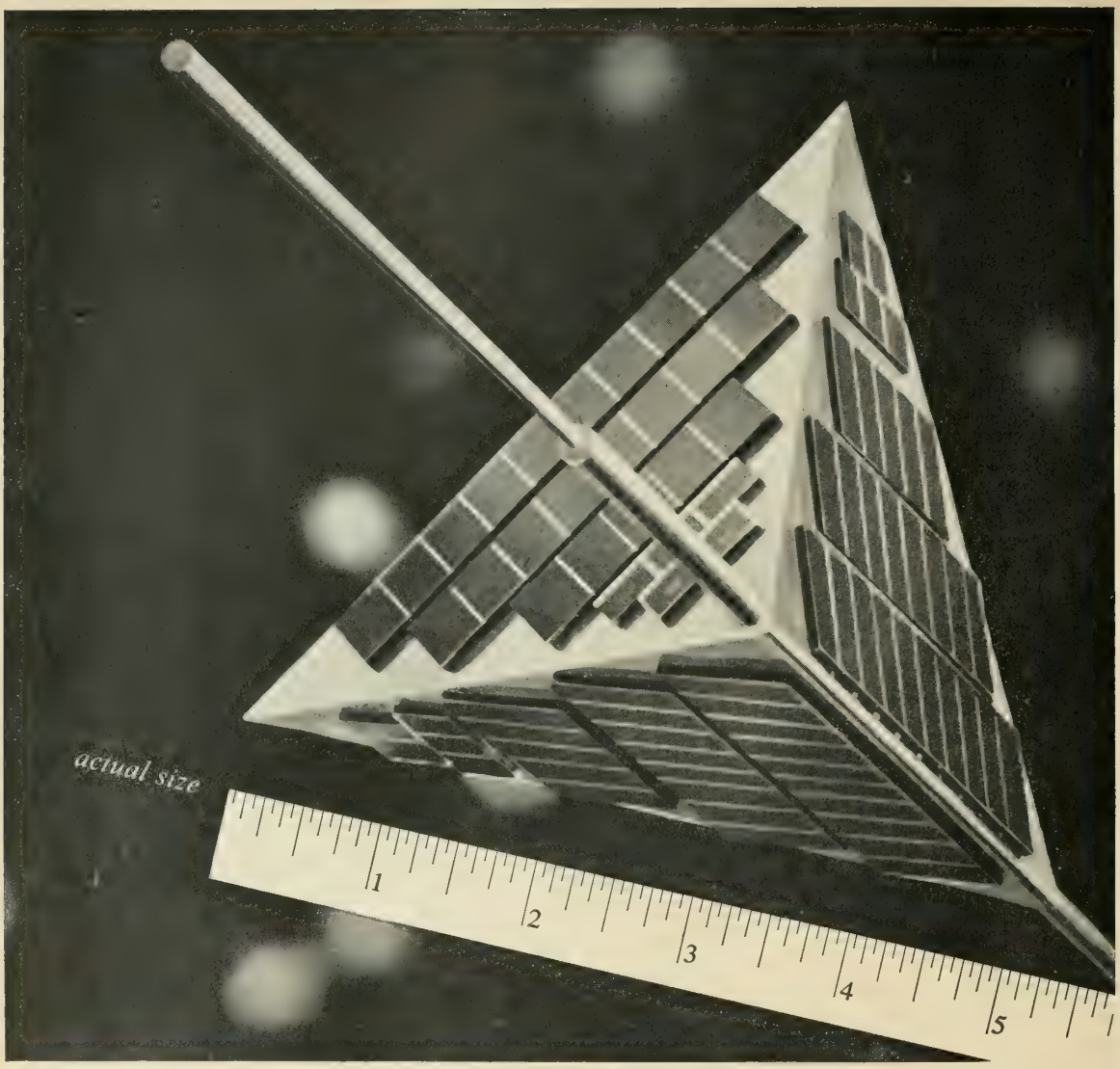
May I personally say that your comments on DOD indecision concerning Air Force super-solid development further confirm my belief that this nation is behind in big booster capability purely because of political differences. We have the necessary technology, financial support in the multi-billions and feasible proposals are being shoved into the faces of experts every day.

But nobody seems to agree with anyone; not even that we are far behind Russia in the Moon race. It is sheer "lunarcy" to believe anything else when we have already decided upon the rendezvous method for the trip, and the booster for the first attempt won't be operational for years.

Where do these political rhubarbs get us? Why should there be a contest between liquids and solids, when both systems are needed? Why should there be a lack of confidence in the solid system when nothing has been proved against solids that the *Polaris, Pershing, Scout, Sergeant, Nike-Zeus* and *Minuteman* have not continually disproved?

Let's put our teams together with full steam ahead. We will be more proud of a team effort even if we should arrive on the Moon second, and our war deterrence will be greater than ever.

Durwood White
Thiokol Chemical Corp.
Alpha Division, Huntsville Plant
Huntsville, Alabama




The world's smallest satellite has been developed by Space Technology Laboratories. Its shape will be different from all other satellites before it. STL engineers and scientists have used a tetrahedral configuration to bring about some remarkable characteristics in a space vehicle. There will be no need for batteries nor regulators in flight. The satellite will have no hot side, no cold side. It will require no attitude control devices. No matter how it tumbles in space it will always turn one side toward the sun to absorb energy, and three sides away from the sun to cool instrumentation and telemetry equipment inside. It can perform isolated experiments in conjunction with other projects. Or it can be put into orbit by a small rocket to make studies of its own, up to five or more separate experiments on each mission it makes.

STL is active on hardware projects such as this and as prime contractor for NASA's OGO and an entirely new series of classified spacecraft for Air Force — ARPA. We continue Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate opportunities in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For So. California or Cape Canaveral opportunities, please write Dr. R. C. Potter, Dept.B-10, One Space Park, Redondo Beach, California, or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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# The Countdown

## WASHINGTON

### Big Solids Briefing This Week

Moment of decision for the Air Force's big solid-motor program is due this week when Secretary of Defense Robert McNamara and NASA Administrator James E. Webb are briefed on the program. NASA is pushing for a program costing about $100 million in a 2- to 2½-year period. Small segment firings of 156-in. motor and about three firings of a 260-in. motor would be included. DOD still favors a less expensive program with firings of a one-third length 156-in. motor and a half-length 260-in. unit. How soon RFP's are issued will depend upon whether the two top officials can come to quick agreement.

### ASP Briefing Scheduled

Top NASA and Air Force officials are to be briefed Sept. 24 on technical research requirements leading to *Aerospace Plane*. It is likely to be many months, however, before the technical responsibilities of both agencies will be detailed.

### President Quick-Briefed on LOR

NASA's top officials counterattacked swiftly in defense of lunar orbit rendezvous after President Kennedy was told on his recent industry tour that many U.S. space experts were unhappy with the decision. In a dramatic mid-air briefing, NASA Administrator James Webb, Moon boss D. Brainerd Holmes and other officials convinced both the President and Vice President of the soundness of the decision. Tip-off to the President that the decision was being questioned came from White House Science Advisor Dr. Jerome Wiesner.

### AF Chief Misses AFA Meetings

Absence of Air Force Chief of Staff Curtis LeMay from the Las Vegas meeting of the Air Force Assn. has raised several interesting questions. Among them: Was he ordered to stay in Washington because he was ready to blow his stack on the issue of military vs. civilian Pentagon control? Who issued the order? Official explanation was that LeMay had to "mind the store."

### Soviet Cape Snoopers Base in Cuba

Russian trawlers carrying electronic gear to probe firings from Cape Canaveral now are based in Cuba. Wholesale cancellation of a number of missile firings on Aug. 30 might have been due to their presence down-range.

### Atlas Sites Get New Firing Control

A new control system to guard against accidental firing is programed for Air Force *Atlas-F* installations. The procedure requires two people to each "turn a key" within three seconds of the other before an ICBM can be launched. The present code-book system of launch signal verification also will be retained. Each book covers several weeks in six-hour periods to permit code changing after every period.

### Space Station Conflict Seen

A new NASA-Air Force clash is brewing over manned space stations. Both agencies want one, but it is unlikely the Administration will fund two programs. A showdown is expected next year when Fiscal '65 budget requests are prepared.

### Houston Center Costs Soar

The cost of NASA's Manned Space Flight Center at Houston continues to spiral upward. The need for the facility was sold to Congress on the basis of a $60-million cost. Now NASA officially admits the total cost will exceed $123 million and could reach the $200 million level.

### Weather Forecast: 14 Satellites

If almost certain joint Commerce Department/NASA approval is received, a total of 14 *Tiros* meteorological satellites will be launched. Six have so far been launched successfully. NASA will fund five more, and Weather Bureau satellite operations under Dr. S. Fred Singer will pay for three operational craft.

## INDUSTRY

### Four Firms Picked for SPRINT Studies

Martin, Douglas, Lockheed and North American Aviation have been awarded contracts ranging from $300-$350 thousand to perform system studies for the *SPRINT* antimissile missile. Awards were made by Bell Telephone Laboratories, the Army's chief technical consultant and manager for such programs. Component development will be a problem since the 10,000 ft./sec. missile will have to withstand 140G forces. Douglas is said to have the inside track.

### Corning Hunts New Markets

A chemical tempering process that imparts five times as much strength to glass than previously possible is spurring Corning Glass Works into a search for missile/space applications. Strength levels up to 100,000 psi have been reached with processed ¼-in. rods and considerable flexibility achieved in flat sheets, the company says.

### Water Test Site Unnecessary

A cutback in NASA's water test requirements has ended plans to reactivate a Navy test installation at California's Salton Sea. The site, used for much of the *Mercury* program's parachute recovery system development, was to have been reactivated within the next few weeks.

## INTERNATIONAL

### New Space Plant Planned for Bordeaux

SNECMA, the French nationalized manufacturing combine specializing in propulsion, will build a new facility in the Bordeaux area of southwest France. Plant production, according to a government report, will be devoted to space and nuclear projects. A staff of 3000 is planned.

### Blue Water Work Continues

Despite cancellation, work on Britain's *Blue Water* missile is continuing. Three hundred employees still are turning out fins for the missile. These are cut and planed from the solid with an accuracy of 0.001-in. and passed to inspectors who carefully examine them. After that, they are thrown on the factory scrap heap. A British Aircraft Corp. spokesman explains: "It is better for the men's morale if they are working." The program was cancelled Aug. 10.

### Pluto Future is Dark

Despite Air Force and Navy support, prospects for the Pluto nuclear ramjet program looked dim last week.

Testimony by Dept. of Defense research chief Dr. Harold Brown before the Joint Committee on Atomic Energy indicated the *SLAM* (supersonic low-altitude missile) program might be cancelled.

Brown said DOD was withholding the AF $24-million appropriation for the program. A decision by Secretary of Defense McNamara is expected next month during review of the FY '64 budget.

Brown was evasive on the project's prospects. Under questioning by subcommittee members, he indicated Tory 2-C reactor tests will continue for some time but little money will be available for development of a flight vehicle or flight reactor tests.

Industry observers concluded from Brown's lack of support that he would recommend cancellation to McNamara.

Fred Payne, deputy to the DOD research director, listed three alternatives for achieving low-altitude penetration:

- A maneuvering re-entry system for ballistic missiles.
- A chemically-propelled shorter-range low-altitude cruise missile, either sea or air-launched.
- An advanced manned aircraft system with low altitude penetration capability.

Brown admitted these merely were concepts.

### Shots of the Week

- The 100th *Atlas* to be launched from Cape Canaveral was successfully fired 5000 miles downrange Sept. 19. The missile—an F model—ejected two cameras from a capsule five seconds after lift-off. It carried with it a capsule of unidentified scientific instruments, as well as a nose cone cassette for flight recording and two other camera capsules.

No attempt was made to recover the scientific package.



*LATEST Nike-Zeus configuration shows blunter control surface near nose of missile.*

- *Tiros VI* was boosted into orbit Sept. 18. (See page 29.)
- *Skybolt,* encountering developmental problems, was destroyed by the range safety officer Sept. 13 after veering off course over Cape Canaveral. Third flight of the two-stage solid-propellant missile was as disappointing as the first two, which ran into igniter problems. Latest problem was reportedly a relay "random failure." The missile is also reported to have autopilot trouble, but it is not known if the latest failure was caused by autopilot malfunction or if the guilty relay was in another part of the vehicle.
- Another secret satellite was launched from Vandenberg AFB, California, by a *Thor-Agena B* booster Sept. 17.
- An operational-configuration *Minuteman* from Wing #1, complete except for warhead, was fired from Cape Canaveral Sept. 18 on a "highly successful" flight more than 3000 miles down range.

### Mariner II Picks Up Speed

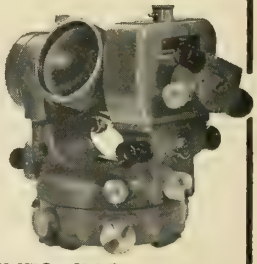
By noon Sept. 24, *Mariner II* is expected to be 4,561,879 miles from the Earth and moving at a somewhat faster speed than before, NASA estimates predicted.

Venus fly-by of the spacecraft is still scheduled for Dec. 14.

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## New Astronauts Named

NASA officials announced selection of nine new astronauts Sept. 17 and indicated five to ten more would be needed to round out Project *Apollo* pilot requirements.

The three Navy, four Air Force and three civilian pilots will serve in Project *Gemini* and perhaps will compose the first U.S. lunar landing team.

New astronauts are: Neil Armstrong, 32, Wapakoneta, Ohio, a veteran civilian test pilot for NASA on the *X-15;* AF Maj. Frank Borman, 34, Gary, Ind.; Navy Lt. Charles Conrad, Jr., 32, Philadelphia; Navy Lt. Cmdr. James A. Lovell, 34, Cleveland; AF Capt. James A. McDivitt, 33, Chicago; Elliott M. See, Jr., 35, Dallas, civilian experimental test pilot for General Electric Co.; AF Capt. Thomas P. Stafford, 32, Weatherford, Okla.; AF Capt. Edward H. White, II, 32, San Antonio, Tex.; Navy Lt. Cmdr. John W. Young, 32, San Francisco.

## Nova Bidders Listed

Fifteen firms are bidding for the *Nova* launch facility study contract to be awarded Oct. 1. They are:

Aerojet General; American Machine & Foundry Co.; Bechtel Corp.; Chrysler Corp.; Brown Engineering Co.; Daniel, Mann, Johnson & Mendenhall; Douglas; Martin Marietta; Rust Engineering; Westinghouse Electric Co.; Vitro; Lumnux Co.; Lockheed Aircraft Corp.; Catalytic Construction Co.; and Holmes & Narver.

## SAC Gets Atlas F Silos

The first operational *Atlas F* silo complex—worth $150 million—was turned over to the Strategic Air Command at Salina, Kans., Sept. 11.

## Bids Asked at Cape

The Corps of Engineers has called for bids to be opened Oct. 10 on construction of a two-story concrete block missile lab to be used by the Air Force and NASA.

The building, to be located at Cape Canaveral, will contain 19,950 sq. ft. of floor space.

## Complex 12 Changes Set

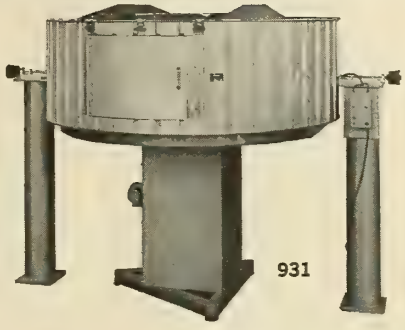
Three major space programs are scheduled to move into Cape Canaveral Complex 12 following its nine-month remodeling job (M/R, Sept. 10, p. 11).

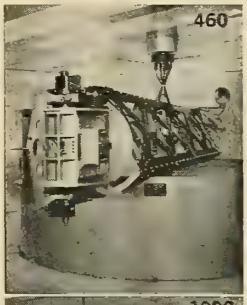
NASA officials said the *Orbiting Geophysical Observatory (OGO), Orbiting Astronomical Observatory (OAO)* and Project *Fire* will be launched from the pad now used for *Ranger* and *Mariner* shots.


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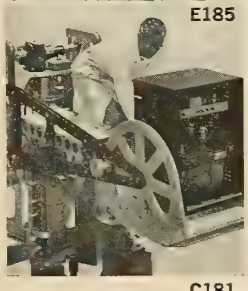
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*Fiscal '64 budget . . .*

# Space Program Set at $7 Billion

***Kennedy Administration postpones major military space spending; NASA budget continues to build***

**by Hal Taylor**

THE KENNEDY ADMINISTRATION is preparing a total FY '64 space budget of about $7 billion—thus putting off a major U.S. military space program for at least another year.

While discussions among government agencies will continue until the budget is finalized in November, an administration official reports that the total will not rise much above that figure.

This is well below earlier estimates that funding in the next fiscal year would hit $8 billion or more.

Although 30% above current fiscal space funding of $5.4 billion, the increase does not represent a crash program in either the civilian or military area.

• **Air Force disappointed**—Hardest hit is the Air Force hope for a far greater space role. The official said that the military space budget will go to about $2 billion, one third higher than FY '63 funding of $1.5 billion. In recent years, however, the military budget has doubled from year to year.

NASA is not getting all that it wants, either. The space agency requested approval of a budget of up to $6 billion, but it is unlikely the administration will approve much over $5 billion. The two other federal agencies with space programs, the Atomic Energy Commission and the Weather Bureau, will get a total budget of $200 to $300 million.

If the $2-billion DOD space budget is finally approved, it will be virtually impossible for the Air Force to initiate any new military space development.

A large part of the increased funds will necessarily be devoted to the development of the *Titan III* launch vehicle. Its total cost, according to DOD, will be $808 million, with about $200 million available in the current fiscal year. With a late '64 flight test target date, a large part of the remaining development funding will have to come from the FY '64 budget.

Increased fiscal '64 funding will also be needed for DOD's two communications satellite projects: high altitude and random.

Air Force also is pressing strongly for, and may win, approval of preliminary feasibility studies and perhaps a program definition competition for a manned orbital development station.

Lesser amounts, but still representing increases over '63, probably will be spent for SPADATS, operation of a navigational satellite system — particularly retrofitting of *Polaris* subs and extension of the system to high-priority surface ships, increased development effort on the "re-oriented" *MIDAS* program and operation and improvement of *SAMOS*.

• **Dyna-Soar stymied** — The Air Force's continuing frustration in the military space area is sharply illustrated by its inability to expand the *Dyna-Soar* program. In FY '63, DOD requested appropriations of $115 million for the manned spacecraft scheduled for flight testing in 1965.

Congress was not satisfied with the size of that effort and voted DOD $42 million in additional funds. Although first balking at spending the money, DOD officials have recently indicated they will use half that amount, bringing FY '63 total to $136 million.

For FY '64, however, DOD has again requested funding of only $115 million.

Reduction in the NASA request is not expected to harm the U.S. manned lunar landing program. Space agency officials earlier indicated their willingness to settle for a FY '64 budget of $4.5 to $5 billion. ■

## Showdown Nears on Anti-tank Missiles

TWO ARMY anti-tank missiles, *Shillelagh* and *TOW*, are heading for a technical showdown in which only one system is likely to survive.

Although *Shillelagh* has been under development for almost three years, some Army project officials feel *TOW* may offer technical and tactical advantages which would doom the older project.

Others anticipate a cancellation of *TOW*. One high Army official has described a recent *Shillelagh* firing as "spectacular."

Last month, the Army conducted *TOW* feasibility tests at Aberdeen Proving Ground, including firing tests of feasibility models of three contractors — Hughes Aircraft Co., Martin Co., and McDonnell Aircraft Corp. Based on the results of these tests, the Army awarded Hughes a contract for further feasibility work.

Approval for a development program has not been given, Army officials stress. Work being conducted now is to determine if one system can fullfill the dual mission outlined for *TOW*. These missions visualize an infantry support system mounted on ¼-ton class vehicles and an armor-mounted anti-tank system.

*Shillelagh* was particularly designed to fit the latter role by mounting on the M-60 tank. However, the program is now far enough behind schedule to preclude this possibility.

Evaluation of the two systems, will be exclusively on technical merit and will include hardware tests, not just paper exercises. Despite reports to the contrary, Army officials insist there has been no political pressure in the *TOW* program.

• **Gilpatric Memo Puzzling**—Although most of the information on the TOW program is classified confidential or higher, Army officials refuse to discuss any aspect of the program. Elementary questions on the types of targets *TOW* would engage, the need for such a system and even the full name of the system for which *TOW*, is an acronym (a tube-launched, optically-tracked, wire-guided missile) cannot be discussed.

Part of the Army's reluctance to discuss the system undoubtedly stems from a memorandum from Deputy Secretary of Defense Roswell Gilpatric specifically forbidding any discussion of the feasibility contract with Hughes.

*TOW* is an in-house Army program, resulting from supporting research done by the Ballistic Research Laboratories at Aberdeen Proving Ground. *Shillelagh* is under development by the Aeronutronic Div., Ford Motor Co.

***excludes hardware bidding...***

# IT&T ComSat Contract Still Leaves Loopholes

***Legal experts see escape clauses as still subject to interpretation***

**by James Trainor**

DEPT. OF DEFENSE contract with International Telephone and Telegraph Corp. for systems engineering and technical advice on communications satellite programs excludes IT&T from bidding on ComSat hardware.

Industry legal experts report, however, that last week's contract is not as exclusive or restrictive as initially reported.

Although the pact precludes IT&T from bidding "on any of the hardware directly associated with the satellite or with ground equipment directly related to the satellite," it includes at least three important escape clauses. Enumerated in Section 3 of the contract, these are:

—Products or processes developed prior to signing of the contract will not be included in the exclusion terms.

—Companies acquired by IT&T that produce equipment usable in a satellite communications system will still be able to bid for hardware contracts.

—Finally, hardware can be procured by the government from IT&T for communications satellite systems upon determination by the director of the Defense Communications Agency that it is in the best interests of the government to do so.

• **A Willing Seller**—The $12.2-million, four-year contract is designed to meet the criticism voiced by the Bell report on government R&D contracting —specifically the conflicts of interest arising when contractors provide technical advice on government programs and later bid for hardware development contracts on the same programs.

The Office of the General Counsel is preparing a regulation spelling out procedures to be followed in future "hardware exclusion" contracts. However, the IT&T contract, a defense official emphasized, although reviewed by the General Counsel's office, does not necessarily represent the restrictions that will be imposed by the new regulation.

In awarding the DCA contract to IT&T, the Defense Department had no definitive authority but acted on the principle of a "willing buyer and a willing seller." To find a "willing seller," however, DOD had to approach "more than four" qualified firms.

Although defense spokesmen were reluctant to admit it, all these firms rejected the DOD proposition. The basis of industry's lack of enthusiasm apparently was the "hardware exclusion" clause of the contract.

• **IT&T's Role Defined**—Under the re-oriented and now nonexistent *Advent* program, the Defense Communications Agency is charged with integration and compatibility of both the spaceborne and ground electronics. The Air Force is responsible for satellite portions of the communications satellite programs, while the Army is to provide the ground systems.

IT&T will assist DCA in the staff planning required to insure compatibility of the spaceborne and ground electronics as well as integration of the complete system with existing military communications networks. This will include providing systems engineering and technological advice to DCA.

Federal Laboratories of IT&T—the research and manufacturing division of the corporation's U.S. Defense Group—will handle the contract with support from three other IT&T divisions: Communications Systems Systems, Inc.; International Electric Corp. and Kellogg. Over-all director of the program will be Dr. William M. Duke, president of Federal labs.

A special systems engineering and technical advice center will be opened in Arlington, Va., to insure a close working relationship with DCA in Washington.

• **Situation Normal: Confused**—On Sept. 8, Secretary of Defense McNamara signed a memorandum approving the DCA plan for organizing and conducting its portion of the ComSat program. Classified confidential, the memo calls for a new deputy director of DCA with two-star rank to head the program.

Strong emphasis was placed on the fact that this man would not be the program manager. Although severely criticized for a lack of central direction in the *Advent* program by Congressional committees, defense officials still stoutly maintain that its ComSat programs do not need a program manager.

A program of requirements—outlining the minimum essential requirements for circuitry and channels between geographical points — has been formulated by the Joint Chiefs of Staff, a defense spokesman said, and will provide the basis for a program definition phase later this year.

Development contracts for the two communications satellite systems will not be concluded with industry until early next year, the official revealed. Following the *Advent* re-orientation, the same defense official estimated that requests for proposals would go out to industry "within the very near future." The optimism of last May was denied last week.

The feeling that "there are too many fingers in the pie" was privately confirmed by one defense official after the IT&T announcement. As he explains it, there is no end in sight to the proliferation of agencies and contractors involved in the ComSat program. ⁘

## AF Space Station

Air Force plans for a manned orbital space station call for an erectable two-man structure with a lifetime measured in months, it was disclosed last week. Booster would be the *Titan III*, permitting the maximum weight of the orbital vehicle to be from 25,000-30,000 lbs.

For the station to become operational in 1966-67, development would have to be initiated within the next calendar year.

This is on the same high-priority time schedule with more elaborate NASA plans for a 175,000 lb., self-erectable structure capable of sustaining a crew of 20-36 for extended periods of time. Booster for the NASA station would be the *Advanced Saturn*.

Neither NASA nor Air Force has an approved program. Both agencies are placing increased emphasis on their space station requirements, with decisions on the fiscal '64 budget to be made within the next several months.

# AEC Emerges as New Space Agency

## *Commission given responsibility for SNAP-50/SPUR development*

**by William Beller**

THE ATOMIC ENERGY COMMISSION emerged as a new space agency during hearings held Sept. 13 and 14 by a subcommittee of the Joint Committee on Atomic Energy.

This became evident when government witnesses testified that tentative agreement had been reached giving AEC responsibility for developing high-power nuclear-electric systems for space vehicles.

First system involved is *SNAP-50/SPUR*, planned for operation early in 1970.

Direct result of the agreement is that NASA and the military will have to include the AEC as a full partner when advance plans are drawn for developing spacecraft needing large amounts of electrical power.

Indirect result is that the AEC probably will start analyzing spacecraft and missions in order to hold its own at the conference table with spacecraft users.

• **Controversy settled** — Agreement among the agencies has come hard (M/R, July 23, p. 12; Feb. 19, p. 12). AEC, NASA and AF for the past year have engaged in a three-way tug-of-war with each agency seeking management responsibility for developing the space nuclear-electric system nominally rated at 300 KWe. AF called its system *SPUR* (Space Power Unit Reactor); AEC, the *SNAP-50* project; and NASA, "an advanced development."

Winner of the contest would be assured of getting facilities and experience that would play a major part in the future U.S. space effort. Realizing this, each participant was temporarily satisfied to hold its ground until it could build a strong nuclear space technology.

Congressional pressure, however, forced the present decision. Though AEC is happy with it, many NASA and AF officials at the working level are disappointed. While still holding that user agencies should develop their own powerplants, they nevertheless say they will do their best to help AEC develop what is now called *SNAP-50/SPUR*.

This space nuclear powerplant is a turbogenerator system operating under a Rankine cycle. Lithium will cool the reactor; potassium vapor will drive the turbine and generator in the conversion equipment. Working temperatures in the system will be about 2000°F compared with the maximum temperature of 1300°F for the *SNAP-8* 30-kw to 60-kw system.

• **SNAP-50/SPUR missions**—There was never any doubt that Congress would have to take a hand in settling the management conflict. If continued, it would have delayed development of future generations of vital spacecraft. During current hearings held by the Joint Committee's Subcommittee on Research and Development, Dr. Harold Brown, Director of Defense Research Engineering, testified that AF has a potential requirement for electrical power in the range of *SNAP-50/SPUR* —300 kw to 1 mw.

"Possible uses are in radar surveillance and mapping, high-powered communications and electronic countermeasures, or electrical propulsion for orbital station-keeping or maneuvering," Brown said. Noting that the Air Force is trying to develop electric-propulsion devices, he said, "I think this is the principal military use."

Brown said NASA is also interested in space power units of *SNAP-50/SPUR* size as well as those in the multi-mw range for deep-space exploration. He agreed with other witnesses that only nuclear energy can supply 100-kw power for extended periods.

Brown observed that DOD and NASA have similar interests in space-power and that AEC has unique capabilities and responsibilities in the nuclear field. He suggested that "the relationship of NASA and DOD with AEC in such development should be as nearly identical as possible."

He further suggested that until NASA or DOD has a requirement for a particular space-power unit, "research and development on all components of the *SPUR/SNAP-50* project should be the prime responsibility of AEC, and the bulk of the funding should be provided by the commission."

With the exception of a decision on funding, Brown's two suggestions were embodied in the tentative agreement reached by DOD, NASA and AEC for management of *SNAP-50/SPUR*.

Other Brown recommendations still open for negotiation: (1) AF and NASA should continue general component development in conversion equipment; (2) AEC should assign specific supporting power-conversion work to AF.

• **AEC funding for space** — Evidence of AEC's impending role as a space agency can be seen in its burgeoning space budget—about $80 million in FY '61; $200 million FY '63. These funds cover operating costs and construction obligations for the *SNAP* nuclear power-source program, *ROVER* nuclear rocket project, *PLUTO* nuclear-ramjet propulsion system, and aerospace safety program. Thus the budget reflects costs of R&D, device fabrication and test operations plus related development and construction of test facilities.

If AEC is given money to pay for most of the *SNAP-50/SPUR* development, as Dr. Brown recommends, at

### Highlights of Hearings

• "Approximately $24 million of our Fiscal 1963 budget will be devoted to research and technology development for . . . high-power nuclear-electric systems. This sum . . . does not include $20 million for our *SNAP-8* system work . . . We are planning major commitments for stage-test facilities at the Nuclear Rocket Development Station [Jackass Flats, Nev.] in FY '63." (James Webb, NASA administrator).

• "Because of reduction in the payload capability of the *Centaur* due to technical development problems, the amount of instrumentation that can be installed in *Surveyor* and, therefore, the amount of power required will be reduced . . . Solar-cell systems will be used in *Surveyor* first flights." (Hugh Dryden, Deputy NASA administrator).

• "We have established a space-power program at Oak Ridge to develop a nuclear-electric power plant in the 100 to 300 KWe range." (Frank Pittman, AEC director of reactor development).

least $300 million must be added to the agency's budget over about 10 years. This is a conservative cost figure recently proposed to AEC by an AF-AEC scientist team.

A Congressman on the House Space Committee familiar with escalating costs of military space projects subsequently predicted costs would be doubled. Brown supported the Congressman's prediction by testifying that costs would be "comparable" to those of the now-dead Aircraft Nuclear Propulsion project—more than $1 billion.

• **Details of agreement**—AEC Commissioner Leland J. Haworth told the sub-committee that the AF and NASA had reached agreement with the AEC on "program objectives, technical concepts, development philosophy and managerial approach for *SNAP-50/SPUR*." When Brown testified later, he said the agreement was still in draft. But he did not indicate any problem getting it signed; nor did any NASA witness.

"During the research and component development phase of *SNAP-50,* AEC will be responsible for development of the power unit and for integration of the reactor and non-nuclear components into a workable system," Haworth said. "Program management will be accomplished through a *SNAP-50/SPUR* project office, responsible to the AEC; this office will be headed by an AF officer, selected by the three agencies, who will report to our Division of Reactor Development."

Haworth explained that the project manager will have an AF and a NASA deputy to help carry out *SNAP-50/SPUR* development and to provide necessary liaison with the nuclear electric-power programs of their own agencies.

**AEC FUNDING OF SNAP, PLUTO, ROVER & AEROSPACE SAFETY**
Operating Costs and Construction Obligations
(millions of dollars)

| | Cumulative through FY '60 | FY Congressional Budget '61 | '62 | '63 | Cumulative through FY '63 |
|---|---|---|---|---|---|
| SNAP: | | | | | |
| Radioisotopes | 9.0 | 2.7 | 4.6 | 3.2 | 19.5 |
| Reactor Units | 19.3 | 16.1 | 39.5 | 44.8 | 119.7 |
| Advanced Space | 0 | 3.9 | 17.5 | 34.8 | 56.2 |
| TOTAL SNAP FUNDING | 28.3 | 22.7 | 61.6 | 82.8 | 195.4 |
| Pluto: | 46.1 | 24.8 | 31.6 | 29.0 | 131.5 |
| Rover: | 83.4 | 33.8 | 66.7 | 84.8 | 268.7 |
| Aerospace Safety: | 0 | 0.2 | 2.0 | 5.3 | 7.5 |
| OVER-ALL TOTAL | 157.8 | 81.5 | 161.9 | 201.9 | 603.1 |

The proposed organization chart shows the deputies with no line authority within AEC. In effect, the representatives are consultants to AEC.

On the other hand, the project manager—though an AF officer—is responsible completely to AEC. He has strong line authority but at the same time is submerged two administrative layers below Frank K. Pittman, AEC director of reactor development. This is worrisome to some AF officials who fear AF needs may be buried in red tape.

• **Problem areas**—There is no sign that either AF or NASA personnel will try to buck the agreement once it is signed. The attitude is, "If Brown (or Webb) says it's okay, we'll go along."

Still, they foresee serious problems if the AEC:

—Fails to design what the user agency wants.

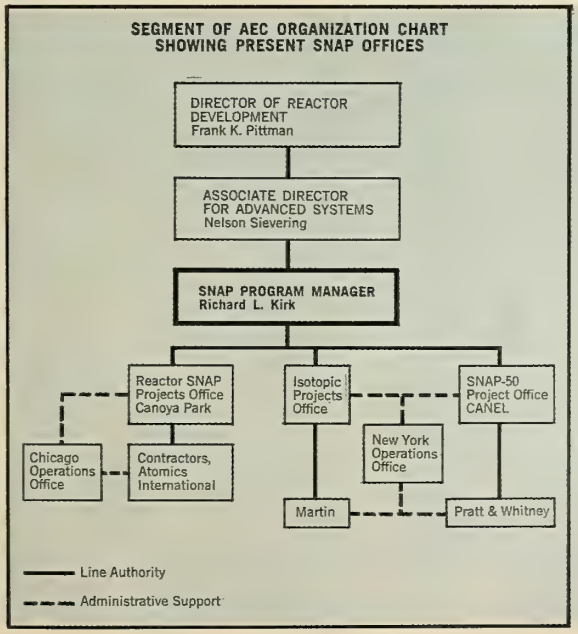
—Decides on specifications not optimum for the user agency.

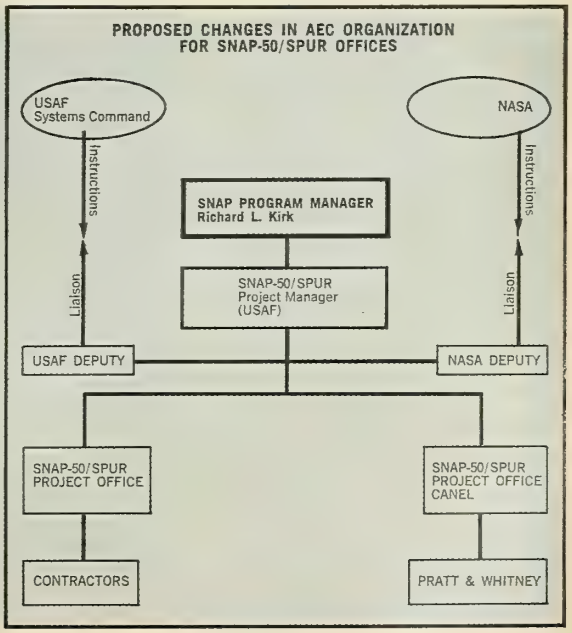
—Rejects "experienced" contractors to give the work to favored concerns.

This last point is a sensitive one with AF officers who feel that AEC signed a negotiated contract with Pratt & Whitney to build the *SNAP-50* reactor simply as a face-saving device for the old ANP program. "Aerojet—the more experienced contractor through its *SPUR* work—was lost to the program," an AF officer complained.

An Aerojet official admitted to M/R that a good case could be built for giving P&W the *SNAP-50* job. "Still, AEC should have at least listened to the Aerojet story," he said.

Regardless of the managerial set-up those involved say they will do their best to make the *SNAP-50/SPUR* program successful. Some of them, however, wonder wistfully where the Congressional space committees and the armed services committees were when the Joint Committee gave its blessings to AEC's managing the next generation of nuclear space power plants. ❖



# Air Force Intensifies Space Campaign

***Six pilots named for X-20 program; Titan III standard launch vehicle unveiled***

**by Russell Hawkes**

LAS VEGAS, NEV.—The accelerating Air Force drive for manned spaceflight capability was underscored here last week by a series of developments in which hardware plays the major role. Delegates to 16th National Convention of the Air Force Association witnessed:

- Disclosure of design details of three Lockheed F-104A jet fighters now undergoing conversion for use as spaceflight trainers.
- Unveiling of the full-scale mockup of the *X-20* space glider and selection of six pilots to fly the joint AF-NASA *Dyna-Soar* vehicle.
- Announcement of *Titan III* transtage capabilities.
- Unveiling of a model of the *Titan III*, to be a workhorse booster for AF manned space missions.
- Proposal by a Martin Co. representative that a network of low-altitude nuclear-powered satellites be established to provide instant military communications.

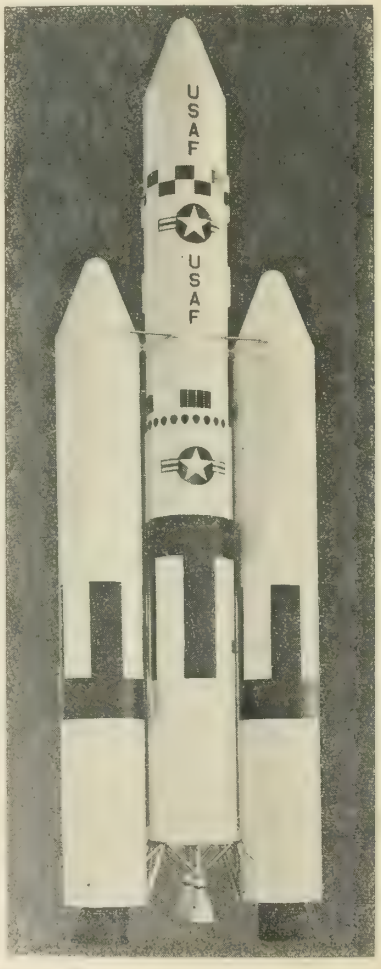
At the same time, Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, criticized those who "still haven't learned that blueprints and studies alone cannot meet aggression." His statement was evidently aimed at the attitude of some DOD officials who want to take a "wait and see" posture on military space.

- **Spaceflight Trainer**—First delivery of F-104A spaceflight trainers is due in late 1963, enabling them to play a useful role in the *Dyna-Soar* program. To be operated by the Aerospace Research Pilot School, the trainers are considered a low-cost conversion measure to fill an important gap in pilot transition from conventional aircraft to the Boeing *X-20* and later winged spacecraft.

The sub-orbital trainers will use small rocket engines to teach pilots techniques and problems of shifting from aerodynamic control to reaction control and back before they actually encounter the experience on research missions. This also will give pilots significant experience of weightlessness and will make it possible to practice the critical unpowered-approach-and-landing maneuver to be used in the *X-20* and already in use on the *X-15*.

Heavy wing-loading of these craft and steep glide angles at low speed call for extreme precision in making final approach pattern and flareout. When the final approach has been entered, there is little or no chance to correct a bad maneuver.

The spaceflight trainers will fly at altitudes up to 130,000 feet. Re-entry heating will not be severe enough for Lockheed engineers to use exotic structural materials in the nose or leading edges. As there is no need for radar on the spaceflight training missions, the standard radome will be replaced by an aluminum-alloy nose.




*Martin's Titan III standard space launch vehicle, unveiled at AFA meeting (model).*

Engine air inlets of the trainers will be extended further forward to get better ram pressure recovery and more thrust at extremely high altitudes. Fire control system, guns, auxiliary fuel tanks, drogue chute, and much electronic equipment will be removed from the fighter to keep weight and balance within limits when equipment necessary for near-space flight has been installed.

Special batteries and radios will have to be used because of low atmospheric pressure at apogee. Different or additional autopilot equipment may have to be carried because of stability problems raised by the high angle of attack reentry techniques developed in the *X-15* program.

The jet reaction control units of the spaceflight trainer will resemble those used in the *X-15* with two each in the nose for pitch and yaw control and two in each wingtip for roll control. Bearing friction of the General Electric J-79 engine will tend to roll the trainer in the same direction as the engine rotor and aerodynamic forces of altitude will be too slight to resist the tendency. Therefore, extra hydrogen peroxide fuel will have to be carried for the roll jets that oppose it.

To prevent rolling from becoming a factor in pilot technique, it will have to be countered by the autopilot. Lockheed engineers considered using an engine brake to halt the torque after engine flame-out on the way up to apogee, but it was judged simpler and cheaper to use jet reaction controls overtime.

Heart of the conversion is Rocketdyne's AR-2, developed several years ago to provide thrust augmentation for fighters. Picked because it can be bought off-the-shelf, it will be installed above the F-104's tailpipe at the base of the vertical fin. It will deliver 6000 lbs. of thrust by burning JP-4 fuel and hydrogen peroxide for about 90 seconds.

• **Titan III transtage**—Greater flexibility in altering a payload's course after orbital injection is the prime capability of the *Titan III* third stage. The transtage, powered by a 15,000-lb.-thrust Aerojet-General liquid-propellant engine will have an extremely long burning duration.

Functions of the transtage after the vehicle has reached its operating area will include changing the payload's orbital inclination to earth, changing the orbit's apogee and perigee, placing it on an earth-escape trajectory, and various other "switch engine" chores.

Engines of the first two stages of the *Titan II* are now undergoing "man-rating" at Aerojet-General's Sacramento plants in preparation for manned space flight use in *Titan III*.

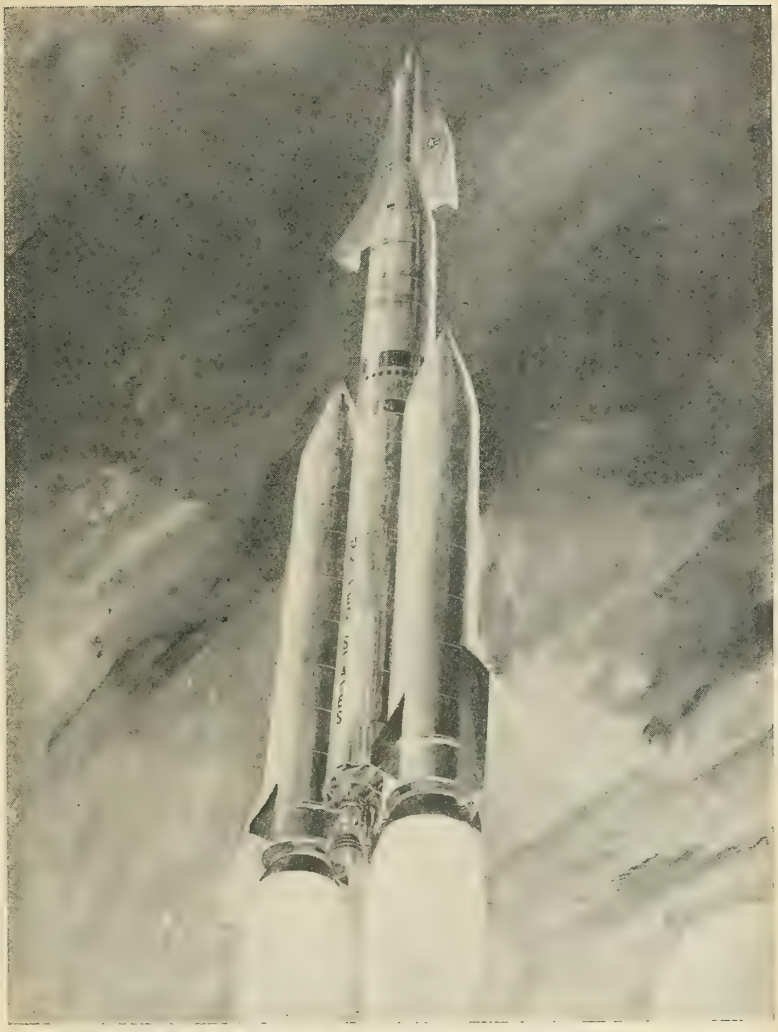
• **Communications Network**—Martin Co.'s Orlando Div. proposed use of 57 satellites weighing 250 lbs. each for instantaneous military communication by voice or data links anywhere in the world. The satellites, nuclear powered and placed in random orbits 1000 miles up, would use a new switching technique to relay messages from one satellite to another automatically. By the automatic technique, the most direct route through the network is picked without prior coordination or regard to relative positions of the satellites in the orbital pattern.

The relay function is selective; it is not merely re-transmission of messages. An electronic address code, reset each time a message passes through a given satellite, allows selectivity. It also overcomes unpredictable network status due to component failure, destruction of the satellite, busy circuits, and other difficulties.

• **Welsh Critical**—To the convention, Dr. Welsh leveled criticism at those who decry the present degree of military participation, or lack of it, in space programs.

"The portion of the defense budget attributed to space for fiscal year 1963 is $1½ billion. That is less than three percent of our total defense budget, but if properly applied it can get a lot of space accomplishment," he said. "It is often cited that the defense space budget is relatively small when compared with NASA's budget of $3.8 billion, but the difference is primarily due to the one large mission: that is, the lunar project, which involves so much in facilities, development and performance."

"There are several reasons why we are not devoting more to space spending by the Department of Defense: (1) Many in this country and abroad fail to understand that U.S. expenditures to keep the peace are as peaceful as any other expenditures; (2) Many civilians and military officials have wide divergence of views as to what the defense missions in space should be; (3) Defense advantages can and do come from space expenditures made by other agencies; and (4) Many still haven't learned the lesson that blueprints and studies alone cannot meet aggression."



*Titan III as it may look boosting the Air Force X-20 (Dyna-Soar) into orbit. Vehicle is a modification of Titan II, and will have more than 2.5 million lbs. thrust.*

Dr. Welsh reinforced his third point by noting that the spin-off from NASA's lunar landing program is "very substantial," since much of the technology for keeping the peace must be developed and used in the LLP. He added that "the lunar trip is not a substitute for military competence in space, but it helps develop that competence."

Concerning Soviet intentions in space, he made no specific statement, but laid some "guidelines" for considering our own programs:

"Never underestimate your opposition."

"Never forget the Soviet objective of world domination."

"Do not minimize the military value of placing heavy objects in orbit and keeping men as well as devices in orbit for long periods."

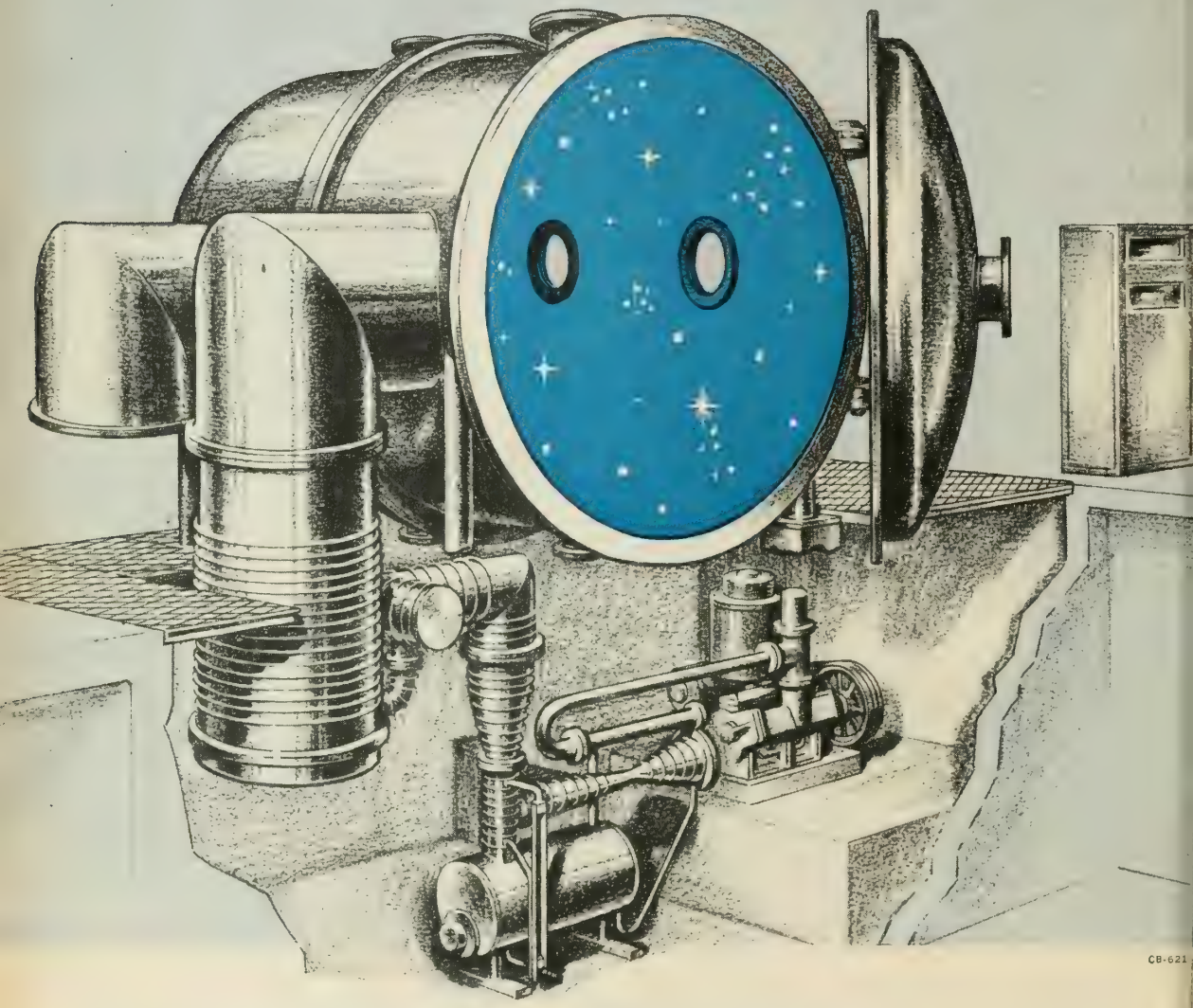
"Do not overlook the blackmail possibilities of weapons in space."

"A satellite does not have to contain a weapon to possess military significance."

The six pilots chosen to test fly the *X-20* are: Maj. James Wood, 38, assistant chief of fighter operations at the AF's flight test center, Edwards AFB; Maj. Henry Gordon, 36; Maj. Russell Rogers, 34; Capt. Albert Crews, Jr., 33, one of the eight test pilots attending the second class of the Aerospace Research Pilot School, Edwards AFB.

Also, Capt. William Knight, 32, a graduate of the AF Institute of Technology; and Milton Thompson, 36, the only NASA pilot selected. ⁂

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RELIABILITY REPORT:

# "The F-2 fuse was blowing repeatedly"

In early 1961 Astrodata completed delivery of 15 identical timing systems to the Pacific Missile Range under prime contract of the U. S. Navy.

A PMR engineer*, in charge of one system at Pt. Arguello, wrote us as follows:

*"I have some information concerning the reliability of the Timing Center which should be gratifying to Astrodata: In over a year of continuous 24-hour day operation, not more than four modules have been removed for repair. (There are over 200 of these modules per system.)*

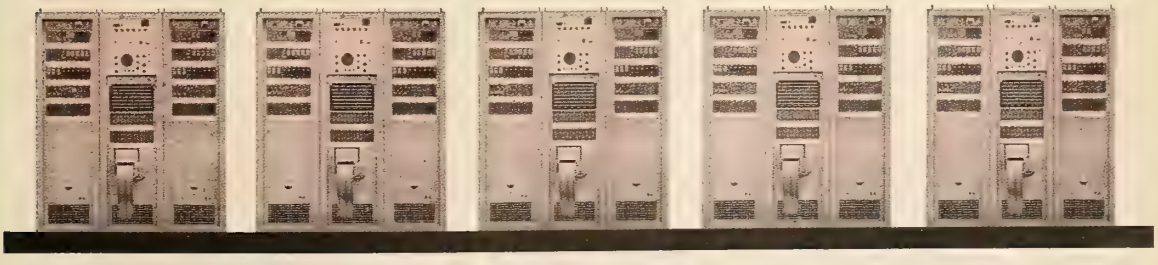
*"The on-site surges usually trip protective circuit breakers, but before this happens, the momentary over-voltage could cause a transistor that performs satisfactorily, with good regulation, to fail.*

*"One modification which might improve maintenance of the power supply (Dwg. #7066-F-254) at our particular station has been suggested by our operational personnel. The 10 amp fuse, F-2, was blowing repeatedly. It is time-consuming to locate the offending component, for it could be in Card H-1, H-2, H-3, or H-4. I use the term time-consuming in a relative sense, considering our obligation to furnish timing to range users on a continuous basis. The operational procedure in the event F-2 blew was to switch over to standby, replace the four suspect cards with spares and re-sync and reset the prime side. At the conclusion of the operation, the old cards could be re-inserted one at a time to find the bad one. However, this was an intermittent failure and would not reveal itself at this time."*

This is the sort of feedback we welcome, since it helps us deliver even more reliable timing equipment to meet the exacting demand for 24-hour continuous operation.

Reports from data reduction facilities and tracking stations throughout the world confirm the reliability of Astrodata timing systems. We have reliability documentation on many of these installations and will be happy to show it to you.

*Name on file.





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# UN Space Talks:

## Progress Is Sought Despite Soviet Moves

UNITED NATIONS, N.Y.—U.S. delegates to the now-adjourned U.N. Committee on the Peaceful Uses of Outer Space remain optimistic about chances of moving ahead in several international space projects—despite new Soviet opposition.

Last week the U.N. main committee approved the Scientific and Technical subcommittee recommendations and report for transmittal to the newly convened General Assembly session. Included in the report are proposals for exchange of scientific data on space programs, encouragement of international programs, and establishment of international equatorial sounding rocket launch facilities.

• **Soviet tactics**—Observers here believe Russian strategy involves efforts to slow progress of the Scientific and Technical subcommittee by raising the still-unsettled legal complications of space flight and exploration.

U.S. observers claim Soviet tactics are similar to the procedural snags the Russians attempted to introduce even at the scientific and technical meetings in Geneva earlier this year. The Russians yielded only when it became embarrassingly obvious that they were standing in the way of any real technical progress.

• **Resistance to weaken**—U.S. sources at the U.N. feel these new procedural tie-ups, like those at Geneva, will disappear once more under pressure from the international body. General Assembly endorsement of the progress to date is expected at this session and the two subcommittees are expected to go back to work in 1963.

Attracting particular attention among the smaller nations as a means to partake of the space age is the U.S.-proposed equatorial launching site for sounding rockets. India has already offered to host this facility. The U.S. can supply much unclassified, non-military hardware for the site—another reason why some U.S. observers feel the Soviets would like to see this project blocked despite their approval in the technical report. ⁂

## Kennedy Labor Statement Draws Sharp Response

President Kennedy's demand that four aerospace companies go along with an advisory board's recommendation and accept labor's union shop demands brought sharp response from industry leaders last week.

Chairman Courtlandt S. Gross of

Lockheed Aircraft Corp. termed both the advisory board report and the President's comments "not in the public interest." He noted that Congress established "free collective bargaining as the approved way to settle labor disputes," and he refused to concede that "three outsiders, no matter how distinguished, are able to say what is right for Lockheed employees better than the company and the union."

The President's statement placing responsibility for settlement squarely on industry shoulders also drew fire from Charles S. Sligh, Jr., executive vice president of the National Association of Manufacturers. By using a fact-finding board, Sligh charged, Kennedy had "chosen to circumvent the provisions of the Taft-Hartley Act for dealing with strikes which threaten to create national emergencies."

Nearly all statements from industry opposing the President's stand noted that an employee vote on union shop now would bind future employees to a compulsory system. To this, Gross added the implication that Lockheed's California employees in effect already had made a decision, as more than half are not union members.

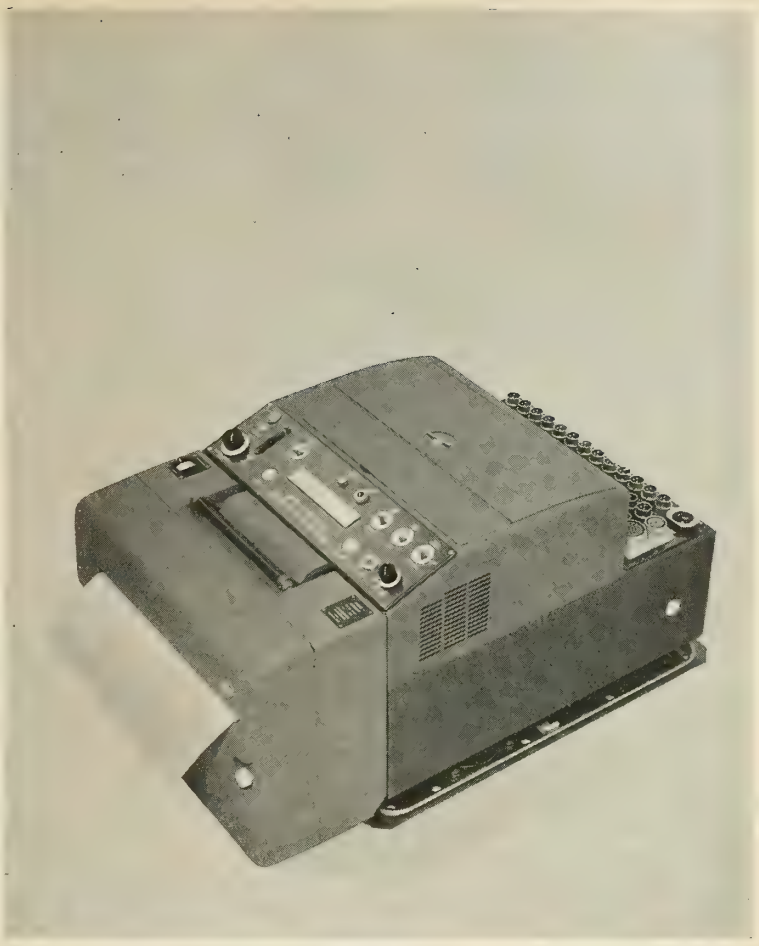
The companies involved in the dispute are Lockheed, North American Aviation, Ryan Aeronautical Co., and General Dynamics/Convair. The unions threatening to strike are the United Auto Workers and the International Association of Machinists—representing a combined group of 100,000 employees. The unions have accepted the recommendations, but complained that the wage provisions "leave much to be desired."

President Kennedy agreed with the unions in his controversial statement, referring to the economic provisions in the board proposal as "not particularly generous." He went on to say that, if the manufacturers refuse to accept the board's settlement plan and a strike follows, "the responsibility would be very clear, I think, to the American people."

Other related events since the dispute arose include:

—Presidential appointment of a second advisory board, headed by Saul Wallen, to study and make recommendations for settlement of a deadlocked IAM-Boeing controversy affecting facilities at Seattle and Wichita, as well as at numerous missile sites.

—Presidential request to Boeing and IAM to hold off the strike until November 15, pending recommendations from the new board; both the company and the union agreed to the postponement. The strike was originally set for Sept. 15. ⌘

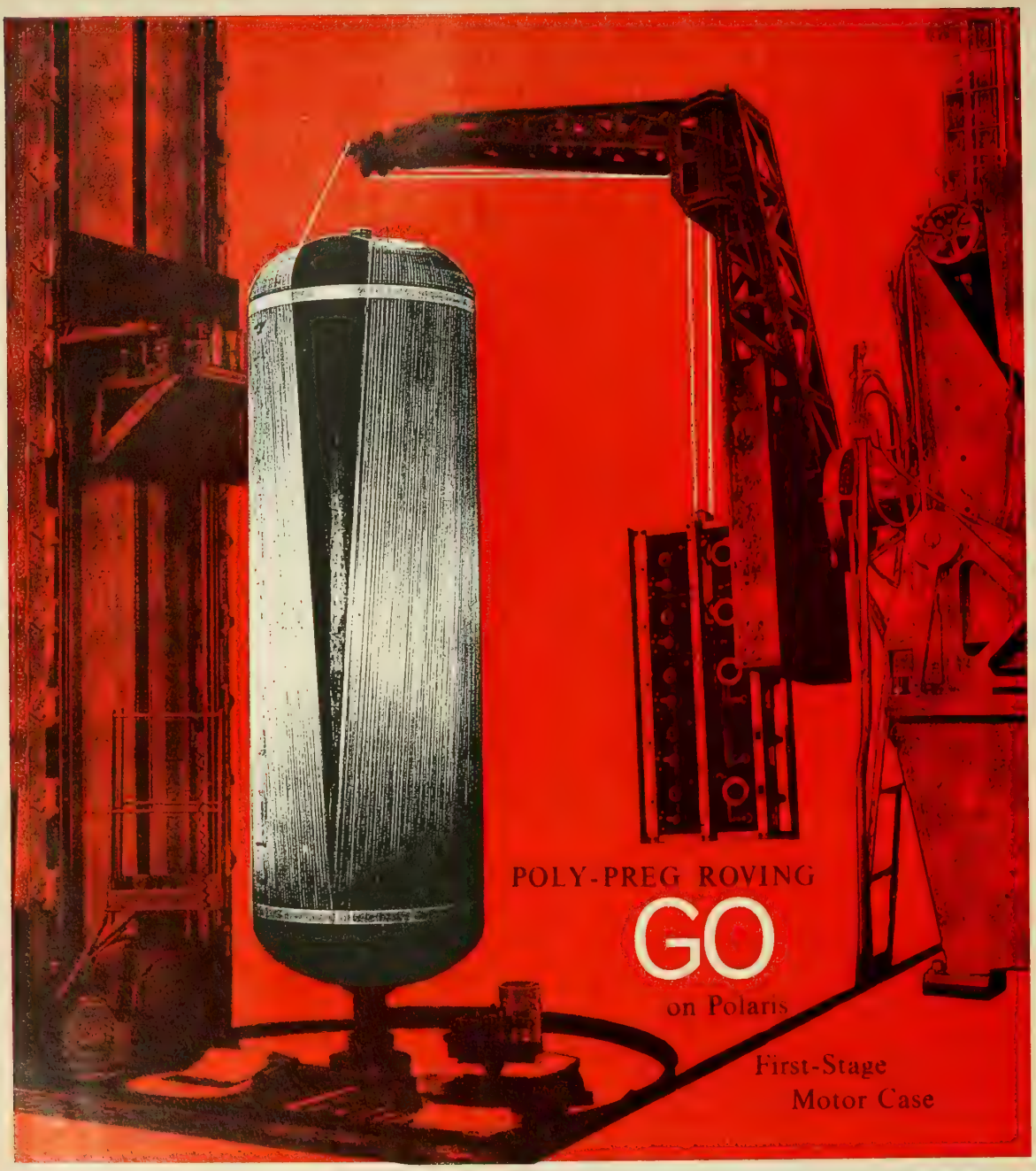



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Cooperative R & D by Aerojet-General and U.S. Polymeric has resulted in the use of Poly-Preg, pre-impregnated glass roving, for filament winding of the Polaris A-3 first-stage motor case.

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PRODUCTION - Poly-Preg roving is advanced to the B-stage, greatly speeding the filament winding operation. Resin baths and drying stages are eliminated; cure-cycle time and problems are minimized. Filaments stay in place as they are layed-up because of the slight tack in the material.

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Circle No. 16 on Subscriber Service Card

# Technical Countdown

## ELECTRONICS

### Raytheon Aims For Accurate Opdar

A tiny optical trigger packing all the energy of a ruby laser discharge into a single pulse of light lasting less than one ten-millionth of a second puts Raytheon on the road to a highly accurate optical radar. Pulse amplitude of the device is more than 10 times that of a conventionally triggered laser of comparable power supply and size. Pulse power is approximately one million watts. Pulses with a rise time of only 20 billionths of a second have been produced, permitting a ranging accuracy of five feet over 10 miles through average clear night atmosphere.

### Space Radar Under Study at Cornell

A Cornell University research team hopes to develop previously unobtainable levels of microwave power at higher frequencies in a program aimed at more effective radar for space exploration and missile defense. The team, under Associate Professor L. F. Eastman, will tackle the problem through both plasma electronics and quantum electronics. Two concurrent investigations will be conducted under the Air Force contract—studies of the generation, maintenance and application of a hydrogen plasma in a confined volume and a study of light from a laser—how it affects matter and vice versa.

### Nuclear Power for SAGE

A nuclear powerplant will soon be supplying all the electrical power needed to operate the Sundance, Wyoming, Air Force heavy radar site, part of the SAGE network. A single reactor core the size of a 55-gal. oil drum will provide the heat necessary to generate electricity for two years before replacement. The Martin Co. unit, PM-1, was airlifted to Ellsworth AFB from the Baltimore Nuclear Division, and shipped the remaining 90 miles by truck. The unit has a net output of 1000 kw and is similar to the 1500 kw plant in operation at McMurdo Sound, Antarctica.

### Super Klystron Under Development

Eitel-McCullough, Inc. is working toward a super-powered klystron tube under a $1.3-million Air Force contract. The contract calls for development and delivery of a tube capable of continuous delivery of 1 megawatt average power at more than 8 billion cycles per second. The highest power available today at these short wavelengths is in the 25,000 to 50,000 watt range. The Eimac tube will be developed exploiting the "extended interaction structure" first proposed by Prof. Marvin Chodorow and Dr. Tore Wessel-Berg of Stanford University.

### Re-Entry Radio Blackout Over?

The Hughes traveling wave tube operating in the frequency range between microwaves and light waves produces a millimeter wave beam which could maintain continuous communications throughout the re-entry phase of a space flight. The tube weighs 16 lbs. and operates the same way as existing high power microwave tubes, but uses techniques of fabrication and electron beam formation and focussing refined to an extremely high degree. The unit has undergone operational tests at 55,000 megacycles with 30% efficiency for more than 200 hours. Development continues under both Hughes and Navy funding.

### Infrared Satellite Spectrometer Perfected

Barnes Engineering Co. has developed a prototype spectrometer designed to determine temperatures over a wide range of altitudes (M/R, Sept. 17, p. 65) easing the problem of accurate weather forecasting. The satellite's function is based on the known distribution of $CO_2$ and involves simultaneous measurements of the infrared energy emitted in the 15-micron $CO_2$ band at several wavelengths. After evaluation tests by the Weather Bureau, the instrument is scheduled for checkout on a high-altitude balloon flight and then on a weather satellite.

## PROPULSION

### Fifth Straight Big Solid Fired by UTC

Sub-scale advanced components destined for the *Titan III* solid strap-ons were tested in the firing of a 70-ton solid Sept. 15 at United Technology Corp. The four-segment solid generated some 250,000 lbs. thrust over 120 sec. after ignition by spraying with reactive fluids. A canted, graphite-lined nozzle amenable to scale-up and an advanced thrust vector control system were checked out in the firing. The test marked the fifth straight successful firing of large solids by the United Aircraft subsidiary.

### Plastic Radar Lenses Possible

Metalized plastic can be used effectively for radar antenna lens systems, as well as reflectors, say experts at Sperry Gyroscope Co. The firm has already installed such systems in their SPG-49 radar, used to guide the Navy's *Talos*, and claims twice the signal gain of an earlier metal version. The lens in this system is molded of plastic-impregnated glass fibers and coated with silver to make it electrically conductive. It is composed of 4100 separate cells that focus high-energy radar beams. There is no loss in strength over a comparable metal system and the plastic is electrically more efficient and much lighter in weight.

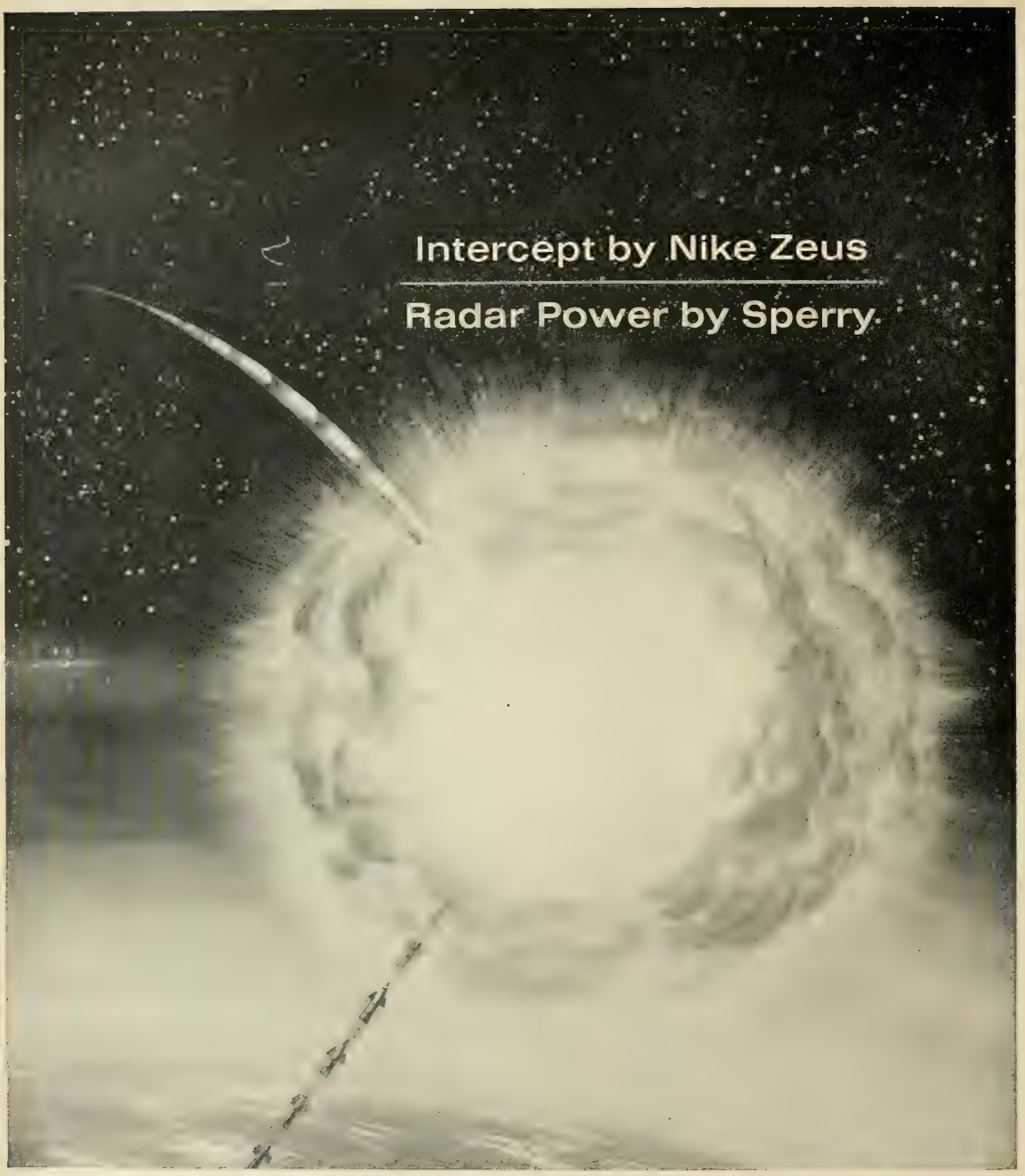
## ADVANCED MATERIALS

### Graphite a Black Body at 6400°F.

Researchers at National Carbon Co., div. of Union Carbide, have found that manufactured graphite radiates energy as an almost perfect black body at its sublimation temperature of 6400°F. The measuring technique involved an arc-image furnace, a synchronous shutter and a system of optical filters. The emission capability of the graphite was found to approach unity. The intricate system separated the reflected and emitted portions of the radiations from the graphite.

### Pfaudler To Develop Production Coatings

Manufacturing methods for applying high-temperature, oxidation-resistant coatings to large, complex refractory metal parts will be investigated by Pfaudler Permutit under an 18-month, $250,000 Air Force contract. Specific objective of the program is to coat full-sized panels with the firm's PFR-6 silicide by the pack cementation process. The contract will lead to industry's first facility capable of coating production molybdenum parts with silicide.




During the critical moments over the Pacific near tiny Kwajalein Island—when the U. S. Army's Nike Zeus System proved that it was possible under test conditions to track and intercept an ICBM-boosted special target vehicle—the Zeus target-track radar performed a vital role. Powered by giant-energy transmitters designed and produced by Sperry, this radar tracked the target when it was still a great distance out. Tracking with deadly accuracy despite the terrific speed of the target, the target-track radar furnished the target-position data needed to guide the Zeus missile to intercept.

Sperry is proud to be a major subcontractor on the Army's Nike Zeus development program, furnishing the high transmitter power for both the target-track radar and the discrimination radar. Western Electric is the prime contractor to the Army Ordnance Missile Command and Bell Laboratories has system design and development responsibility.

SPERRY

***SURFACE ARMAMENT DIVISION,*** *SPERRY GYROSCOPE COMPANY · DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N. Y.*

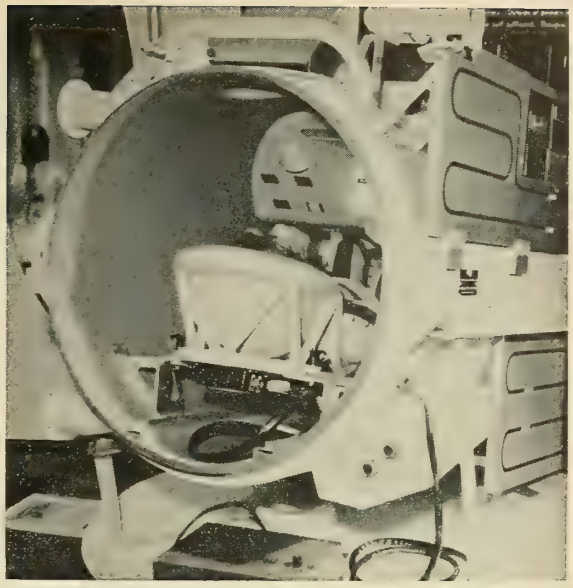


Circle No. 1 on Subscriber Service Card

# NASA Studies New Animal Satellites

## *Seven monkey-carrying vehicles planned in three-to-four-year BIOS II program*

by Heather M. David



*MOCKUP OF Lockheed's advanced biomedical capsule (ABC), which is being considered for use in BIOS II, was designed for BOSS program. Garrett Corp. produced environmental system.*

NASA IS ACTIVELY studying a plan to begin launchings in early 1963 in a new animal satellite program.

About seven satellites will be orbited for from three to 14 days during the next three or four years. Contract award is expected in the next two weeks in the program, now referred to as *BIOS II*. One of the items getting favorable consideration is the former Air Force *BOSS* (Bioastronautic Orbital Space System) program.

Budget will be somewhat less than $50 million over the three to four year period. The Air Force will provide technical assistance. The program is being administered by Bioscience Programs, Office of Space Sciences, in cooperation with the Ames Research Center and NASA's Office of Advanced Research and Technology.

• **Two vehicles**—The first two or three satellites probably will be modified *NERV* capsules left over from NASA's early *NERV* and *BIOS I* programs, and would be launched by *Scout* vehicles.

A variety of experiments will be carried, from cellular studies to those involving small animals such as mice.

According to Experimental Biology Chief Dr. Dale Jenkins, NASA is now requesting the scientific community to submit experiments, and a number has already been received. They will be screened thoroughly by a NASA study panel that has been meeting regularly to firm up other details of the program.

The second phase probably will consist of three or four launches of larger, *BOSS*-type capsules, with *Atlas-Agena B*'s. This series will begin launching in 1964.

Although the original AF-*BOSS* concept called for a 50-lb. chimp, NASA experts say they might use a rhesus or pig-tailed monkey to provide room for more experiments.

Several capsules already designed are under consideration. These include the *Discoverer* animal capsule (General Electric and Lockheed), the *BIOS* (GE), the *NERV* (GE), the *BOSS* (Lockheed/Garrett) and the McDonnell *Mercury* capsule like that used by space ape Ham. A decision on the capsule is expected within the next two weeks.

The satellites would be divided for launch in either of two orbits: a low circular orbit below the Van Allen belt, or a highly eccentric orbit extending well into the belt. Depending on vehicle, launch may be from Wallops Island, PMR or AMR, NASA spokesmen say. All satellites will be recoverable.

• **Experiment goals**—The program is designed to fill gaps in basic knowledge of effects of the space environment on living organisms, particularly weightlessness and the types of radiation not reproducible in the laboratory. Nothing that can be done on the ground will be duplicated in this program, said Dr. Jenkins.

Probably only the early results will be incorporated into the *Apollo* program because of scheduling, but NASA feels that this basic research is necessary. Some parts will contribute to *Apollo* and *Gemini*.

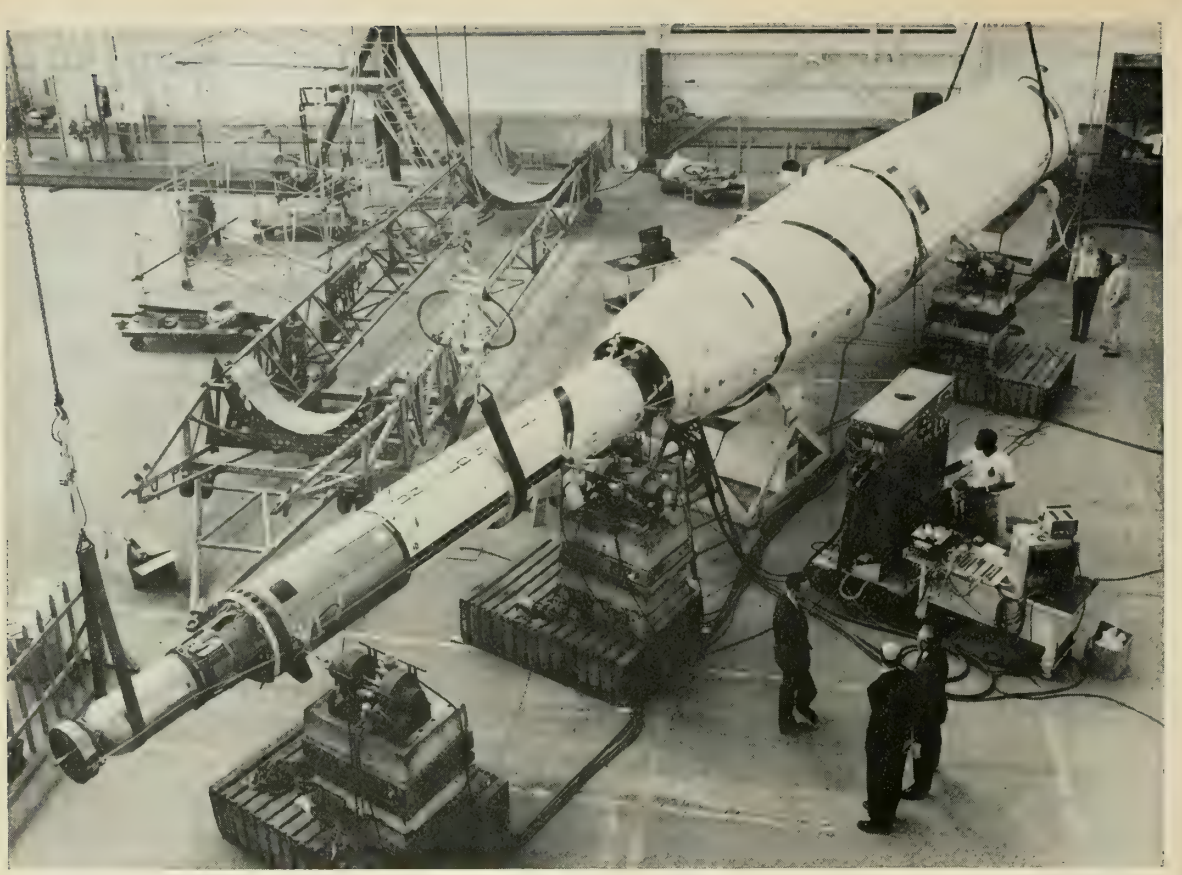
"Man and larger primates have some compensatory mechanisms which might prevent spaceflight effects from showing up at first," says Dr. Jenkins. "If we get a smaller animal, very heavily instrumented, up there for a couple of weeks we will be able to see what really happens."

Contractors are now being requested to submit plans for instrumentation that might be used in *BIOS II*. Among the studies desired by the Biosciences office are: internal nervous system probes, cardiac output indicators and intensive psychomotor studies.

Choice of an oxygen supply and purification system also rests with the study panel. Either stored oxygen or a regenerative superoxide system may be used.

Animals used in the smaller experiments will be furnished by the individual experimenters. However, larger primates used in the second phase of the program will be raised, trained and prepared at NASA's Ames Research Center.

• **Air Force cooperation**—Air Force bioastronautics experts have for a number of years urged an animal satellite program. At one time, plans for animal laboratories were carried in both the *Discoverer* and *BOSS* programs. DOD recently ruled that Air Force could not participate in funding such a program. Terms of Air Force assistance to NASA in the program have not yet been worked out. They might involve transfer of personnel to NASA from the Air Force. ⌘



*FULLY ASSEMBLED Delta undergoes vibration test at Douglas Missile and Space Systems Div., Santa Monica, Calif.*

space systems

# Reliable Delta To Get More Work

## *NASA eyes two new versions of the booster for missions throughout decade*

**by Chris Butler**

CAPE CANAVERAL—Two new versions of the *Delta* launch vehicle are expected to assume heavy workloads throughout the remainder of this decade as NASA adds additional missions to the booster's roster. Total missions already completed or now assigned to *Delta* stand at 33.

Last vehicle of the original *Delta* group was used in last week's launch of *Tiros VI*. The early type will be succeeded by intermediate *DSV-3A* and advanced *DSV-3B* models.

Representatives of Goddard Space Flight Center told MISSILES AND ROCKETS their optimism over *Delta's* future is based on the continuing need for data in planning manned flights to the Moon and beyond, R. H. Gray, chief of Goddard's Field Projects Branch, said also that relatively low cost of the booster and its exceptional record of reliability were prime factors in its choice as a workhorse for additional orbital and probe missions.

First launch of the intermediate *DSV-3A* is expected imminently carrying Goddard's *S3A* satellite, intended to study energetic particles. The vehicle is now in its gantry on a Cape Canaveral launch pad.

The *DSV-3B*, which will become operational early next year, will greatly increase capacity of the *Delta*. The circular orbital capability at 500 nautical miles will rise sharply from about 430 lbs. on the *DM-19* to 700 lbs. on the *DSV-3A* and 800 lbs. on *DSV-3B*.

The *Delta* project, which had its first launch in May 1960, was originally programed for five to seven vehicles.

• **Reliable vehicle**—Reliability and economy of the program quickly increased the number of missions. The total stood at 14 in March 1961, more than 20 by the summer of 1961 and now calls for 33 missions to be flown.

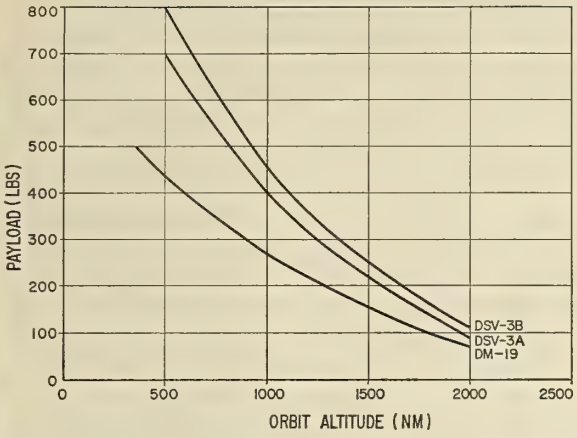
The original *Delta* vehicle was built from off-the-shelf items used in the *Thor* IRBM and the *Vanguard* space programs.

First stage was the highly-reliable *DM-19 Thor*, which delivered 150,000 lbs. of thrust for 160 sec. The fuel was LOX and RP-1.

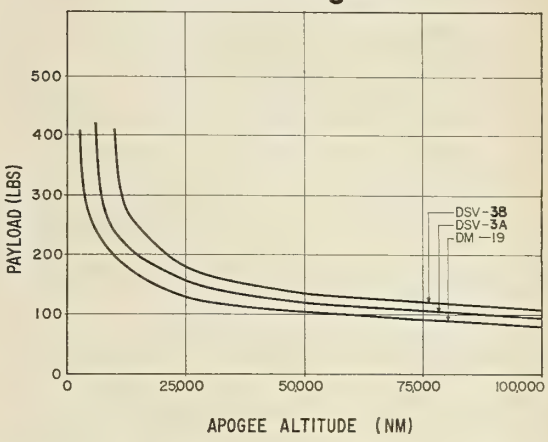
Aerojet's AJ 10-118, burning UDMH and white inhibited fuming nitric acid, produced 7500 lbs. thrust for 120 sec.

Third stage was composed of the

**Circular Orbit Capability (AMR Launch)**




**Elliptical Orbit Capability (AMR Launch) (100 NM Perigee)**




Allegany Ballistic Laboratories *X-248-A-5(D),* a solid-propellant stage with 2750 lbs. thrust during a 38-sec. burn.

Bell Telephone Laboratories radio command Series 300 equipment guided the first and second stages, and the third stage was spin-stabilized for flight.

The first *DM-19 Delta* failed in its assignment to launch the *Echo I* balloon into orbit. The mishap was blamed on the coast flight control between second-stage burnout and third-stage ignition.

Since the flight, *Delta* has scored 13 successful launches in a row. Eleven have been with the full configuration *Delta,* and two were *"Big Shot"* balloon launches, although one payload later burst.

The satellites, probes and sub-orbital missions included *Echo I* and *II, Explorers X* and *XII, Tiros II, III, IV, V* and *VI, OSO I, Ariel I, Telstar* and the two *"Big Shot"* balloon tests.

• **Improvements** — The new *Deltas* employ a more powerful first-stage booster. The improved *Thor,* burning LOX and RJ-1, will deliver 165,000 lbs. thrust, an increase of 10% over the *DM-19.* Burn time will remain the same.

RJ-1 is ramjet fuel having a higher density than RP-1 (although both are kerosene-based) and will deliver greater thrust per gallon.

Principal external change will be a shorter *Thor* body.

The advanced *DSV-3B* also will employ a longer-burning second-stage motor, which will deliver 7500 lbs. thrust for 165 sec. Principal changes in this stage are the 45-second increase in burn time and the change from white to red fuming nitric acid.

White fuming nitric acid will be used in the next two *DSV-3A* launches, then all *DSV* second stages will switch to the red acid to take advantage of its slightly higher specific impulse and better storage and handling characteristics.

The third stage of *DSV-3A* and *DSV-3B* remains unchanged from the one used on *DM-19 Deltas.*

Guidance of the first stage has been changed to take advantage of the improved BTL radio command Series 600 equipment.

All but one of *Delta's* currently assigned missions will be made with the three-stage configuration. The exception is *Syncom,* which contains a small motor to propel it into a synchronous orbit.

Also on the books for an early launch is *Telstar II* and a probe to report on deterioration of the H-bomb-induced radiation belt.

*Syncom,* most ambitious of the communication satellites to date, is scheduled for launch in the first quarter of 1963.

The satellite and probe schedule calls for two more *Telstar* satellites, another *Tiros,* two more *Syncom* satellites, another *OSO,* the initial *Relay* satellite, and three unnamed satellites to study atmospheric structures and energetic particles.

• **Program management**—Management of the *Delta* program at the Atlantic Missile Range is in the hands of R. H. Gray, chief, Field Projects Branch, Goddard.

For the launch, Douglas Aircraft Co. supplies the test conductor, and the test controller comes from the local branch of Goddard. The latter has a *Thor* advisor supplied by AFBSD. ⌗

## *Tiros VI* in Orbit; Will Assist *MA-8*

CAPE CANAVERAL—*Tiros VI,* successfully launched here Sept. 18 aboard a three-stage *Delta* vehicle, has a dual mission—to locate and track tropical storms, and to transmit weather data in preparation for Astronaut Walter Schirra's scheduled Sept. 28 six-orbit *Mercury* flight.

Launch of the 281-lb. "weather eye" was timed to insert it into an orbit that will not conflict with *Tiros V* when ground stations send commands to "dump" pictures stored on tape. *Tiros VI's* vital statistics: apogee, 442 statute miles; perigee, 425; period, 98.7 minutes; inclination, 58.3°.

*Tiros VI* was originally scheduled to be launched in November, to cover the height of the hurricane season, but was sent aloft around the Earth's middle earlier to help *Tiros V* in providing highly accurate global weather forecasts for the *MA-8* shot. One of the two TV camera systems aboard *Tiros V* is no longer working.

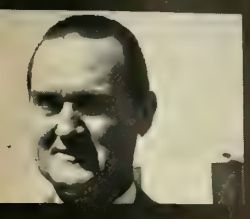
The new satellite is identical to *Tiros V,* except for an infrared experiment that was eliminated because it couldn't be fabricated in time for the flight. Metal ballast is carried to compensate for the weight loss.

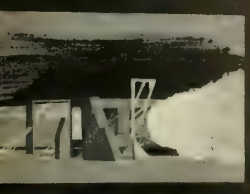
*Tiros VI's* two independent television cameras permit wide scanning of the Earth's surface on half-inch vidicon tubes. Their lenses cover 600,000 and 232,000 miles, respectively. The satellite can be tilted by use of a magnetic attitude control that consists of a wire coil around the bottom. Electricity flow through the coil creates a controllable magnetic field that interacts with the Earth's magnetic field to provide gradual tilting to change camera angles.

The satellite also carries a north indicator to permit easy orientation to ground stations at Wallops Island, Va., and the Pacific Missile Range.

*a lot of people know something about space...*







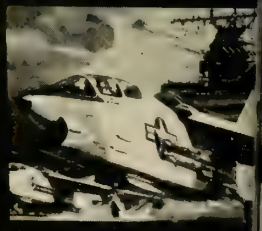
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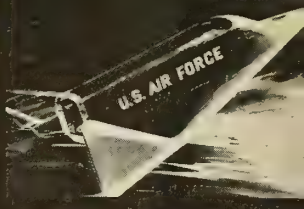




. . . conceptual design / launch and space vehicles / propulsion testing / guidance and communication / ground support and range tracking / life sciences / electronics



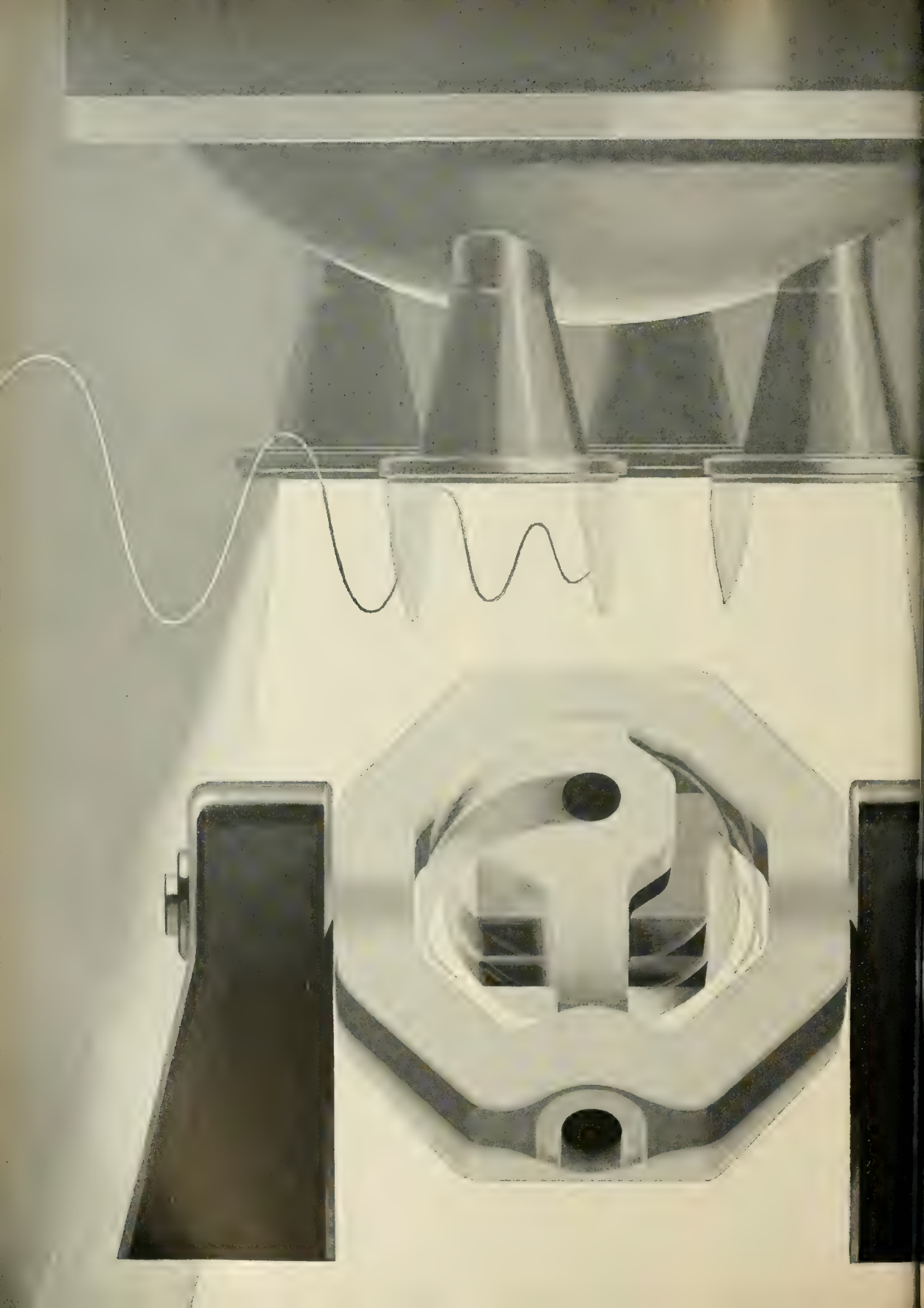
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Finally, the whole guidance and flight control package is put through simulated flights for final checkout. But that isn't all. The simulator also performs the role of post-flight evaluation detective when it is fed tapes of actual flights, and the effects are observed on earth-bound hardware.

It is with such elaborate equipment, guided by engineers and scientists of outstanding calibre, that Lockheed Missiles & Space Company has attained its place in the forefront of missile and space technology. And such progress is constantly creating key positions for other engineers and scientists of proved ability, so they may take up the exciting challenges offered by Lockheed and share in its rewards.

This unusual organization is located in Sunnyvale and Palo Alto, on the San Francisco Peninsula in California. For an informative brochure, "Your Place in Space," write to: Research and Development Staff, Department M-31A, 599 North Mathilda Avenue, Sunnyvale, California. An Equal Opportunity Employer.



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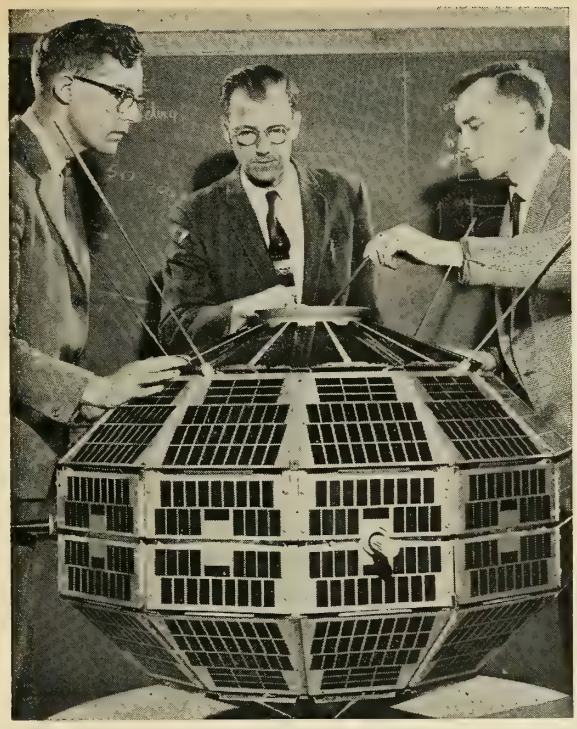
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*Canadian scientists with 320-lb. Alouette, to be launched by Thor-Agena B into upper atmospheric orbit.*

space systems

# Canada's Alouette Poised for PMR Launch

***Topside sounder is first spacecraft not built by U.S. or Russia; NASA to attempt near-circular 600-mi. orbit***

NASA WILL ATTEMPT its first orbital flight from the Pacific Missile Range this week with the scheduled launch of the *Alouette* topside sounder satellite.

Developed by Canada, the satellite is the first spacecraft to be designed and built by a nation other than the U.S. or U.S.S.R.

Earliest launch date is Sept. 26. The ionosphere spacecraft will be boosted to a 600-mi. circular orbit by a *Thor-Agena B* vehicle. Its primary objective will be to measure disturbances in the upper atmosphere and to aid in discovering how their effect on radio communications may be overcome.

The satellite also will attempt to measure the effects of solar particles on ionization at high altitudes.

*Alouette* was built by civilian scientists of the Canadian Defense Research Board. It and the U.S.-sponsored *S-48* satellite to be launched later this year will support each other in ionospheric investigations.

The spheroid-shaped *Alouette* will conduct four experiments, three for the Defense Research Telecommunications Establishment (DRTE) near Ottawa, and a fourth on behalf of Canada's National Research Council (NRC).

A fabrication technique originated in Canada will give the spacecraft a unique feature—a 150-ft. radio antenna —believed to be the longest to date in a space vehicle. Associated with it will be another antenna 75-ft. long.

Both are made of thin, heat-treated steel and are stored on drums within the spacecraft much like a carpenter's tape rule. They will be extended after the satellite separates from the launch vehicle. Testing of the antennas and the feasibility of topside sounders was carried out at NASA's Wallops Island Station in Virginia by rocket firings in June, 1961.

The 320-lb. *Alouette* will be launched in a southeasterly direction into a near-circular orbit of 80° inclination at an altitude of about 600 miles. It will orbit the earth about every 105 minutes, passing 10 degrees of latitude from the north and south poles.

Approximately 6500 solar cells covering the outer spacecraft shell will provide power for the research instrumentation by converting sunlight into electrical energy to charge the satellite's batteries. RF transmission will be terminated automatically after a year.

The primary *Alouette* experiment will employ topside sounder instrumentation to probe the ionosphere below the orbiting spacecraft to the F2 maximum (300-400 km.). The sounder will attempt for a year to measure the way the number of free electrons in the ionosphere changes daily with the time of day and latitude. This will be accomplished by sending out "sweeping" radio signals from 1.6 to 11.5 megacycles.

Two other experiments will measure the galactic or radio noise that appears to originate in outer space, and the radio noise produced within the ionosphere itself.

Instrumentation in the satellite will conduct the fourth experiment by observing cosmic rays, the energetic particles that enter the earth's atmosphere from the sun and from cosmic space.

Design and construction of the spacecraft was carried out by DRTE with assistance from Canadian industry and NASA's Goddard Space Flight Center. Much of the final testing took place at Goddard, and the center will contribute to the data-collection phases by tracking the satellite and obtaining telemetry records at its world-wide Minitrack station network. NASA also is providing the *Thor-Agena B* launch vehicle.

Scientific data will be obtained at 13 ground stations. Three stations have been constructed in Canada by DRB and will be manned by Canadian personnel. Two stations—one at Singapore and the other a tracking ship in the South Atlantic—will be operated by Great Britain. Eight of NASA's Minitrack stations also will track and record data.

While the long antennas are sounding the top levels of the ionosphere from above, the lower layers will be sounded at various locations by ground-based equipment. Comparisons of the topside and bottomside results will help establish the relationships sought by scientists. ⌘



## THE NEW MEN

Today man's work — in a sense even man himself — is undergoing a dynamic metamorphosis. In almost every area of human endeavor, change is the only constant.

What may be the most revolutionary of all changes we are witnessing is the one occurring within the aviation industry. Today it is better known as the aerospace industry . . . and it is the leader of a new age: the age of space.

It is being created by new men, with new ideas, new processes, new techniques.

Once the most productive sound in this industry was the roar of assembly lines. Today the most productive sound is often silence. The silence of men thinking. Thinking of things never done before . . . of metals never used before . . . of tools never designed before . . . of systems never conceived before.

Airplanes are still being built. Yet they are planes vastly beyond the ken of even the wildest of yesterday's dreams. And this is just one part of the industry.

Nearly every scientific discipline known to man is being probed, explored, and used within the aerospace industry. Nuclear science, electronics, rocket propulsion, life sciences, chemistry, and communications are just some of the fields being pursued.



Nuclear scientists are building miniature nuclear reactors.

Botanists and physiologists are studying the possible use of plants in the free world's program to explore space.

Electronics engineers are studying microelectronics.

Rocket engineers are perfecting giant rocket engines that will have millions of pounds of thrust.

Geologists are extracting water from rock.

Bio-engineers are designing hand-tools for use in space.

All these men, and many others in even more diverse fields, are part of today's aerospace industry.

These are the men who are pushing forward every frontier of science. These are the men who are creating the systems of tomorrow and the industries of the future.

These are the new men.

**North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.**

*Thiokol development:*

# Instant Foam Padding for Astronauts







ASTRONAUTS COULD ride out expected or unexpected high g-forces with a foam encapsulation system under development at Thiokol Chemical Corp.'s Bristol Div.

Foamed into a plywood enclosure, John Weaver was subjected to accelerations up to 6 g's on the centrifuge at the AeroMedical Acceleration Lab, Naval Air Development Center. Although the urethane foam was sectioned in this run, it could be instantaneously generated in a spacecraft's cabin.

Thiokol experts say the foam system could enable an animal to absorb 1000 g's in free drops. The Russians have experimented with animal-carrying capsules in free drops up to this level but did not use foam plastic as a restraint system. Thiokol envisions a host of applications for generated urethane foam —from helicopter sea landing pads to soft landing lunar systems for unmanned probes.

Foam generators could supply adequate protection to pilots ditched in subzero waters. The foam is a good insulator and the reaction itself, being exothermic, would supply a small amount of heat. The manned tests followed a series with a sheep and a dummy.

Prior to tests with a fully-encapsulated subject, preliminary tests also were carried out with a partially-encapsulated man.

Such a generator could be programed to operate at the first sign of abnormal g-forces while still maintaining manual initiation. Pre-positioned severing devices, explosively actuated, would free the astronaut after the danger passed. While encapsulated, the subject would have only his fingers free to move. ⌗








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# ENGINEERS!

## *There's a New Spectrum of Activity at CONVAIR!*

We're at work on the long-range development of vehicles for space, air, land, water and underwater applications. This broad new spectrum of activity is a far cry from the "old" Convair which gained eminence as one of the world's largest manufacturers of airplanes. **But despite the new scope of interest, Convair remains an engineer's company.**

For more than two decades Convair has recognized that any company producing highly engineered products must build its organization around engineers. Engineering groups and individual engineers are given a loud voice in product development. To us this is simple logic, simply because it has consistently resulted in superior products.

Added advantages enjoyed by engineers at Convair are the superb community benefits. Uncrowded, resort-like San Diego has excellent schools, abundant housing at uninflated prices, plus four colleges and universities offering a wide range of courses, including advanced studies in engineering and the sciences.

Current requirements are detailed on the next page. If they stimulate your interest, we invite your inquiry — either on the attached inquiry card, or directly to Mr. S. H. Imdieke, Engineering Personnel Administrator, Department 6-128,

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This card may be folded and sealed or stapled and mailed in complete confidence. It will enable the professional staff at General Dynamics Convair to make a preliminary evaluation of your background. A personal interview can be arranged in your city by appointment. Every completed inquiry will be acknowledged.

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Name

Street Address

Telephone

City & State

Nearest major city (if applicable)

**Education:**
College Graduate: Yes ☐ No ☐
Degree: BS ☐ MS ☐ PhD ☐

**Major Subject:**

| | | |
|---|---|---|
| Aeronautical Engineering | ☐ | Mechanical Engineering ☐ |
| Electrical Engineering | ☐ | Mathematics ☐ |
| Electronic Engineering | ☐ | Physics ☐ |

Other

Are you a U.S. Citizen?

**Experience:**

Primary Specialty

Years of experience in primary specialty

Secondary Specialty

Additional comments, if any, concerning your job interests.

Fold

M&R . 9

# SENIOR ENGINEERS

The new spectrum of activity at Convair has created immediate, long-range openings for highly qualified engineers in a variety of fields. These are responsible positions and require individuals who possess not only technical competence, but who have demonstrated qualities of leadership and the ability to communicate their ideas at a management level.

**The most urgent requirements are for specialists in the following fields:**

### ELECTRONIC SYSTEMS DESIGN

Development of both ground and airborne systems in the fields of instrumentation, telemetry, control systems, and communications. A BSEE and a minimum of five years' experience in development of electronic systems required.

### AERODYNAMICS

To conduct studies of aerodynamics performance, stability, and control in the areas of S/VTOL, GETOL, supersonic configuration analysis, and hypersonic configuration analysis. An appropriate engineering degree and five years of related aerodynamic experience required.

### THERMODYNAMICS

To conduct studies involving hyper-velocity impact, aerodynamic heating, reentry heat transfer, nuclear and rocket propulsion, and internal aerodynamics and propulsion for ground effect machines, VTOL and GETOL applications. Work also concerns environmental control systems for both manned and unmanned space vehicles. A degree in AE or ME and five years of related experience required.

### GUIDANCE DYNAMICS

Current guidance work involves application to missiles, high-performance aircraft, spacecraft, underwater systems, celestial mechanics, insertion analysis, and trajectory analysis. Specific experience in one of these areas desirable; background in various guidance disciplines and in non-linear control system techniques required. A degree in AE, EE, ME, Physics or Applied Mathematics and Mechanics, plus three years of experience in this field necessary.

### CONTROL DYNAMICS

Work involves the analysis, synthesis and development of complex flight control systems. A background of servomechanism theory is preferred. Familiarity with non-linear analytical techniques and a working knowledge of analog computing techniques highly desirable. A degree in AE, EE, or ME and two years of applicable experience required.

### RELIABILITY

To prepare, direct, and conduct advanced research and analytical studies which require extensive application of mathematical and statistical theory. Requires a thorough understanding of engineering principles involved in order to estimate the reliability of complete missile and support equipment systems. Must be able to determine and evaluate mathematical approaches for solving complex and unique reliability problems. A degree in Mathematics or Physics, plus experience in dealing with advanced reliability problems, required.

### POSITIONS ALSO EXIST FOR SENIOR-LEVEL ENGINEERS IN THE AREAS OF STRESS, MATERIALS RESEARCH, AND HYDRODYNAMICS.

To learn more about Convair's new and rapidly expanding spectrum of activity, mail the attached inquiry card or write to Mr. S. H. Imdieke, Engineering Personnel Administrator, Department 6-128, General Dynamics | Convair, 3313 Pacific Highway, San Diego 12, California.

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# Big Engines:

## Aerojet Injector Units Aid Liquids, Cryogenics

COLORADO SPRINGS, COLO.—The application of large-thrust-per-element injector units to both cryogenic and storable liquid rocket engines of over one-million-pounds-thrust appears to offer major advantages in performance and simplicity.

Preliminary work along these lines, conducted by Aerojet-General under Air Force funding, indicates that such injector types could be incorporated in a multimillion-lb.-thrust engine using as few as 100 orifices. A more conventional injector system in this size engine would require the slow and costly process of drilling some 15,000 fuel and oxidizer orifices. It would also require a complex manifold system for propellant distribution and face cooling.

Results of the Aerojet work were described here in a presentation authored by Dr. J. A. Bottorff, manager, advanced chemical propulsion department, Space Propulsion Div., Azusa, Calif.; John M. Klacking, senior engineer; and Benjamin E. Chantry, development engineer, at the Seventh Symposium on Ballistic Missile and Space Technology co-sponsored by the Air Force and Aerospace Corp.

The term "element," as used here, is an injection unit containing the minimum number of orifices that will provide combustion. A triplet element, for example, has three orifices.

One triple-type element studied has individual streams as large as one inch in diameter. In tests, various element configurations using both cryogenic and storable propellants have shown high performance characteristics which compare favorably with theoretical performance. The triplet unit appears to provide good propellant breakup and mixing by the kinetic energy and momentum of the impinging streams.

• **Variable thrust feature**—The large-thrust-per-element concept has primary application to large-thrust booster engines. But it lends itself to another area—the development of a single, efficient and continuously variable thrust engine. Because of the small number of orifices required and the large orifice diameter, the large-thrust-per-element injector can be designed easily for thrust variations by throttling at the injector. This is done with a movable tapered pintle which varies orifice and propellant flow rate. This type of thrust control is difficult with conventional injectors because of the number of pintles re-


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### Engineering Analyst

To perform cycle and aero-thermodynamic analyses of high-performance propulsion systems. Prepare study applications, correlate subsystem performance, create analytical techniques for unique propulsion cycles.

### Heat Transfer Engineer

Analytical and experimental treatment of heat transfer problems in aerospace power systems. Work will include radiation, ablative, and regenerative cooling of combustion chambers and exhaust nozzles, aerodynamic heating, cryogenic and liquefaction systems, component integration.

### Thermokinetic Analysis

Establish analytical and experimental programs in aerodynamic, thermodynamic, and kinetic reactions. Work involves combustion research with unique high-energy propellants for future aerospace power systems and detailed analysis of dissociation and recombination in exhaust nozzles.

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quired and close machine tolerances.

In the injector study program, Aerojet used a transparent-wall thrust chamber to observe the propellant spray fan, ignition characteristics and combustion gas recirculation. The company also made a detailed review of injector technology and factors affecting propellant mixing and liquid atomization. During these studies, some injector types were eliminated because of their apparent unsuitability for scale-up.

Injector elements involving combinations of aerodynamic drag and surface tension effects—showerhead elements, for example—do not appear suitable for orifice size scale-up. Flow rate from the orifice increases proportionately to the second power of the diameter, but stream tube surface increases only as the first power of the diameter. Ratio of surface area (where shear action occurs) to the stream cross-section decreases as stream size increases. Thus, the mixing effect of aerodynamic drag or surface tension decreases as element size increases.

Injector elements in which atomization is governed primarily by liquid turbulence—such as hollow-cone types—also appear unsuitable for scale-up for similar reasons.

Rejection of the two element types above leaves a possible method of achieving atomization in a large injector element through liquid disintegration by application of an external force. The force can be applied by stream impingement on the one or more other streams as in doublet or triplet types, or by stream impingement upon a solid surface. In each of these systems, momentum of the stream striking another stream or stationary surface, provides the external force application. Energy for droplet production is supplied by momentum of the liquid stream, i.e., the breakup force.

For conventional injectors with a large number of closely spaced orifices or elements, interaction among adjacent elements can help provide a uniform mixture ratio. This is exemplified in the impingement of fuel and oxidizer streams upon each other to achieve a high degree of mixing. Interaction, however, cannot always compensate for an injection system which provides poor propellant mixing. This is particularly true for an injector with a small number of large thrust elements.

Aerojet is enthusiastic about the possibilities and potential of its study program. No upper limitation in size has been found. Much of the work was part of a continuing program to determine scaling characteristics of large liquid propellant engines, and to compare scale-up theory with practical developments and hardware performance. ⌗

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Recent developments make the months following November crucial because the National Aeronautics and Space Administration will be making final procurement and development decisions on many major programs: AEROS/ADVANCED RELAY/NOVA SUPER BOOSTER/ADVANCED SYNCOM/LUNAR LOGISTICS SUPPLY VEHICLE (each will cost hundreds of millions of dollars)/LUNAR EXPLORATION MODULE FOR APOLLO SPACECRAFT (estimated cost over $1 billion).

M/R, the Weekly of Space Systems Engineering, will cover each of the above programs and projects and provide in-depth reports of the sweeping mission and program changes at each NASA center caused by the recent decision to use Lunar Orbit Rendezvous for the first Manned Lunar Landing.

Missile/space prime contractors and sub-contractors advertising in this issue will benefit from: TIMELINESS/SYSTEMS-ORIENTED EDITORIAL COVERAGE OF ALL IMPORTANT NASA PROGRAM AND PROJECT DEVELOPMENTS/BUDGET BREAKDOWNS AND FORECASTS/38,064 ABC AUDITED PAID CIRCULATION/1,000 BONUS CIRCULATION TO KEY NASA PERSONNEL.

**Issue date: November 26; Closing date: November 5, 1962.**
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## Speaking of Burroughs

Burroughs Corp. President Ray C. Eppert said last week that his company's R&D emphasis has turned to investigating cryogenic phenomena and optical scanning devices. Speaking to the Washton Society of Investment Analysts, Eppert cited a variety of laboratory developments that led to products now in production.

"We believe we are at the point," Eppert said, "where previous research will be paying for the new research, with more and more left over."

Eppert presented figures showing that in the last decade Burroughs personnel has doubled, its world-wide revenues and working capital have quadrupled, and its total assets have multiplied by nearly five times the 1950 figure. The company averages $100 million annually in defense orders, he said.

The Burroughs computer that guided the *Mariner II's Atlas-Agena* booster is "the first large-scale solid-state computer ever delivered and operational on site," Eppert claimed. By the end of next year, he said, the same computer will be participating in eight separate space programs, including *Gemini*.

Eppert told the group that NASA has given his firm "a very important order" for a B5000 computer and peripheral equipment at the Marshall Space Flight Center. Payment will be about $1½ million for the system, to be used for investigating data reduction techniques in space programs.

## Industry Facilities

The Martin Co. facility used last year for the Nation's first out-of-silo launch of a heavy ICBM has been turned over to the Air Force. The test facility has been converted by Martin under an AF Systems Command contract for use as a SAC missile crew trainer prior to completion of *Titan II* operational bases now being built in Arizona, Arkansas and Kansas. . . . *Sylvania Electric Products Inc., subsidiary of General Telephone & Electronics, will build a 100,000-sq.-ft. electron tube facility to replace three existing plants at Brookville, Pa. Foundation and steel work has already begun at the 20-acre site of the new plant, which is expected to be operational late next year.* . . . General Electric Co. will transfer nearly 300 employees from Syracuse, N.Y., facilities to its new military communications dept. at Oklahoma City by Jan. 1. GE will also lay off more than 500 employees at Syracuse as current military contracts are completed. . . . *A new Zimney Corp. facility for production of solid-propellant motors, pyrotechnic devices and igniters will occupy 337 acres in Kern County, Calif. The firm's Monrovia, Calif., headquarters announced acquisition of the land but did not say when construction would begin.* . . . Officials from Raytheon Co.'s Lexington, Mass., headquarters have been surveying Houston real estate possibilities for an electronics engineering laboratory for the company's support of the Houston Manned Spacecraft center. In discussions with banking officials and industrial real estate brokers, Raytheon reportedly showed interest in ready-built buildings as well as undeveloped sites. . . . *Grumman Aircraft Engineering Corp.'s $5-million Space Engineering Center, now under construction at Bethpage, N.Y., is scheduled for completion early next summer. Grumman has spent over $12 million in the past four years on new facilities, increased personnel and other items in an attempt to secure bigger pieces of space age markets.*

## Profits: Up and Down

Charles F. Horne, president of the Electronic Industries Association, believes that electronics sales in the U.S. will reach a record annual figure of more than $13 billion in 1962, topping the 1961 figure by over $1 billion. He names as reasons for the market growth new civilian space programs, expanded defense spending, and growth of industrial sales. Though military programs are responsible for better than half of today's electronics market, Horne expects industrial sales to hold the greatest promise for expansion and profit. He considers rising foreign competition to be the greatest threat to the future of U.S. electronics sales. . . . *Manufacturers of printed circuit boards hold a more pessimistic view of profits in their industry—and with good reason, according to an Institute of Printed Circuits survey. IPC says profits of its members in 1961—after taxes—averaged 1% as compared to 3.2% in 1960. Participants in the survey represented about 40% of the $48-million sales for independent circuit board producers last year. Another IPC survey pictured these firms as operating at only about 65% of capacity, with competition keen and many companies operating at a loss.* Large and small companies in the field had similarly pessimistic profit pictures, IPC said.

## Stock Offerings

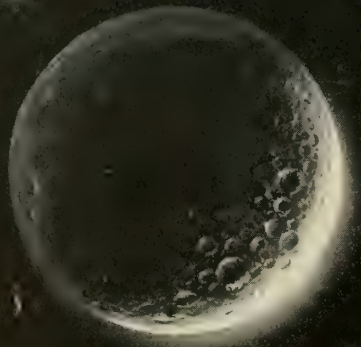
Electronics Capital Corp. of San Diego, Calif., will distribute to some of its shareholders a part of its common share holdings in Potter Instrument Co., Inc., Plainview, N.Y. ECC shareholders of record Sept. 28 next month will receive a common share of Potter for each 10 ECC shares owned. ECC owns more than 600,000 shares of Potter common stock. . . . *Chomerics, Inc., Cambridge, Mass., has completed a successful stock offering that raised $200,000 and resulted in an over-subscription. Officers of the firm handled issuance of the 40,000 shares of common stock directly, without underwriting. The aerospace plastics manufacturer expects to reach a break-even point by the end of October and to continue profitable operations from that point. The offering was considered unusual, in that it came when the market was depressed for such growth issues.*

ORIGINALYSIS IN SPACE

## TARGET: Operation Leapfrog

Today, our target is the moon. Should we approach this mission on the limited basis of marginal propulsive power? Or should the solution of each current mission be founded on a propulsive system so readily expandable that we can, in the very next breath, leapfrog past Diana—and land on Mars? Capabilities and competence exist now to do just that.





**Concept: New and daring,** based on the sector assembly of high-energy solid propellants, and the high mass ratios possible with Spiralloy® glass filament-wound structures.

**UNLIMITED POTENTIAL**

This is a concept for producing boosters of virtually unlimited size and thrust. One, for example, which, utilizing 10 million pounds of solid propellant in 108 sectors, would develop a thrust of 20 million pounds . . . enough to put 300 tons in low-earth orbit, or to boost a manned expedition to Mars and back.

**EXISTING CAPABILITIES**

A product of Hercules originalysis, the concept draws on existing facilities of many producers throughout the nation. Propellant is manufactured at present with cast sectors limited in size only by transportability. Sectors are delivered to the assembly site and stacked in position.

**FAST DEVELOPMENT**

Assembly is completed when the resin-impregnated glass filament is wrapped around the stacked propellant. This operation, too, calls on standard procedures — requiring only a basic mechanical motion. Its adaptability to superboosters such as this — 150 feet by 38 feet — is merely a matter of development at the launch site.

**HERCULES CAN DO!**

For those who believe, as Hercules does, that the space race is purely and simply a **thrust** race, we have compiled considerable documentation of our concept and its proposed programming. For details, write: Chemical Propulsion Division, Hercules Powder Company, 910 Market Street, Wilmington 99, Del.



*HERCULES*

**FIRST IN CHEMICAL PROPULSION**

XP62-1

Circle No. 9 on Subscriber Service Card

# —contracts and procurements—

## AWARDS

### AIR FORCE

$37,440,068—**General Dynamics Corp.**, for installation and checkout of *Atlas* missiles and for provision of ground support equipment (2 contracts). Work to be done at San Diego, Calif.

$35,220,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for additional research and development work to the *Skybolt* missile.

$27,100,000—**Thiokol Chemical Corp.**, Bristol, Pa. for Stage I *Minuteman* solid propellant rocket motors and related material (2 contracts). Work to be done at Brigham, Utah.

$6,000,000—**Martin Marietta Corp.**, New York City, for research and development on vehicles for a space program (supplemental contract). Work to be done at Baltimore, Md.

$5,150,000—**International Telephone and Telegraph Corp.**, New York City, for fabrication and delivery of electronic equipment (supplemental contract). Work to be done at Paramus, N.J.

$4,673,663—**Systems Development Corp.**, Santa Monica, Calif. for development and preparation of system training programs.

$3,924,105—**Philco Corp.**, for work on space programs. Work to be done at Palo Alto, Calif.

$2,500,000—**Space Technology Laboratories, Inc.**, Redondo Beach, Calif., for work on space programs.

$2,200,000—**Rand Corp.**, Santa Monica, Calif., for research in aerospace sciences.

$1,946,660—**Radio Corp. of America**, New York City, for production of time division data link equipment. Work to be done at Camden, N.J.

$1,087,000—**Martin Marietta Corp.**, New York City, for missile verification firings of *Titan I* missiles.

**National Carbon Co.**, New York City, for the production of 3 cylinders of graphite and study of its high-temperature behavior in the large shapes required for solid fuel rockets (undisclosed amount).

### ARMY

$2,500,000—**Fairchild Stratos Corp.**, Hagerstown, Md., for research, development and testing of the AN/USD-5 long-endurance, multi-purpose target drone.

$1,790,000—**Bechtel Corp.**, San Francisco, Calif., for architect and engineering services in connection with design of space environmental simulator chambers for the NASA Manned Spacecraft Center, Houston, Tex.

### NAVY

$1,432,000—**Northrop Corp., Nortronics Div.**, Anaheim, Calif for retrofit and overhaul of *Polaris* shipboard test equipment.

$1,038,519—**Howard Research Corp.**, Arlington, Va., for engineering services, documentation, installation and testing of fleet ballistic missile training facilities at the guided missile schools at Dam Neck, Va., Charleston, S.C., and Pearl Harbor.

$248,544—**B. F. Goodrich Aerospace and Defense Products**, Akron, Ohio, for production of full pressure flying suits.

$50,000—**United Technology Corp.**, Sunnyvale, Calif., for a feasibility study of hypergolic ignition of solid propellants.

### NASA

$4,900,000—**General Electric Co., Computer Dept.**, Phoenix, Ariz., for continued support to the computation division of the Marshall Space Flight Center.

$96,419—**Space Technology Laboratories**, Redondo Beach, Calif., for the study of buckling of shells under dynamic loads.

$78,089—**Airborne Instruments Laboratory**, Deer Park, N.Y., for advanced design studies for sounding planetary ionospheres.

**United Aircraft Corp., Corporate Systems Center**, Windsor Locks, Conn., for an investigation of systems which might augment human capa-



# R/M ASBESTOS-PHENOLICS

**The component: NOZZLE INSULATION**

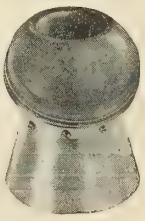
**The missile: POLARIS**

Searing heat in critical nozzle areas of the Polaris missile would cause most materials to lose their strength, dimensional stability and other desirable mechanical properties.

Yet in firing after firing, nozzles insulated with R/M 150 RPD Pyrotex® molding compound withstand the effects of this elevated temperature for the required amount of time.

This proved asbestos-pheolnic ablates uniformly. It holds its dimensional stability under the combined attack of heat, corrosion and extreme shock. Permits weight savings without sacrificing strength.

R/M asbestos-phenolics in the form of felts, mats, tapes and molding compounds are specified for almost every U.S. missile. If you want predictable performance at a price you can afford, talk to the reinforced plastics specialists at R/M.



Polaris missile nozzle of R/M Style 150 RPD Pyrotex molding compound

**RAYBESTOS-MANHATTAN, INC.**

Reinforced Plastics Department, Manheim, Pa.

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

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ENGINEERS • SCIENTISTS

*CAN YOU CARRY A PROJECT FROM CONCEPTUAL REALIZATION TO LABORATORY DEVELOPMENT IN ONE OF THESE AREAS:*




If your answer is "yes" we sincerely believe that Link Division/General Precision, Inc. can offer you an unusual opportunity to employ your full professional talents on meaningful, long-term programs. The Engineers and scientists we are seeking to fill a number of select openings will have the ability to depart from off-the-shelf concepts and the competence and confidence to work in previously unexplored areas.

*To arrange a convenient interview, direct your inquiries in confidence to:*

Mr. J. T. Gibbons

POSITIONS ARE AVAILABLE TO INDIVIDUALS WITH PREVIOUS EXPERIENCE IN:

- Optical Systems
- Photogrammetry
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- Analog/Digital Systems
- Mechanical Systems

LINK DIVISION
GENERAL PRECISION
BINGHAMTON, NEW YORK

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bilities for manned space flights to make man more compatible with his spacecraft environment (undisclosed amount).

**Whirlpool Corp.,** Benton Harbor, Mich., for building food and waste management equipment for the two-man *Gemini* spacecraft which will perform prolonged orbital missions starting in the 1963-64 period (undisclosed amount).

**Ling-Temco-Vought, Inc.,** Dallas, Tex., for development of a unique composite-entry heat protection system for manned spacecraft (undisclosed amount).

### INDUSTRY

$12,000,000—**Arde-Portland, Inc.,** Paramus, N.J., from **Thiokol Chemical Corp's Wasatch Div.,** for the manufacture of an undisclosed number of thrust vector nozzles for the first stage engine of the *Minuteman* missile.

$5,250,000—**Straza Industries,** El Cajon, Calif., from **Aerojet-General Corp.,** for rocket nozzle assemblies for the *Minuteman* missile (several contracts).

$850,000—**Cosmodyne Corp.,** Hawthorne, Calif., from **General Technology, Inc.** and the **University of Southern California,** for two space chambers and ten high-pressure truck-mounted liquid-nitrogen pumping systems.

$500,000—**NRC Equipment Corp.,** Newton, Mass., from **McDonnell Aircraft Corp.,** for six space simulation chambers and associated vacuum equipment.

$200,000—**McCormick Selph Associates, Inc.,** Hollister, Calif., from **Martin Marietta Corp.,** Orlando, for exploding bridgewire ordnance components for the *Pershing* missile.

$200,000—**Giannini Controls Corp.,** Duarte, Calif., from **Martin Co.,** for gyro packages for use in the *Gemini* launch vehicle.

$169,000—**Consolidated Vacuum Corp.,** Rochester, N.Y., from **CEC/Bell & Howell,** for a high-vacuum pumping system for use in testing ion propulsion engines.

**R. D. Werner Co., Inc.,** Greenville, Pa., from **Boeing Co.,** for structural scaffolding to be used on rocket preparation pads at Coral Beach, Fla. (undisclosed amount).

**Twin Industries Corp.,** Buffalo, N.Y., from **Westinghouse Corp.,** for radar and power supply enclosures for the *Typhon* shipboard missile guidance system (undisclosed amount).

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

Direct Support (Free Flight) Weapons Systems Div.
Directorate of Procurement and Production,
U.S. Army Missile Command
Redstone Arsenal, Ala.

Metal parts for the improved *Honest John* rocket motor, XM31E4. Period of performance to be from effective date of contract through June 1964 for bid "A" and bid "B". The date set for opening of proposals covering item 8 below is Nov. 9, 1962. Items and quantities to be procured are as follows: (1) XM31E4 rocket motor, bid "A", 540 each—bid "B", 786 each, (2) immobilizer assembly, bid "A", 540 each—bid "B", 786 each, (3) resonance suppressor, bid "A", 540 each—bid "B", 786 each, (4) igniter, bid "A", 590 each—bid "B", 866 each, (5) pedestal assembly, bid "A", 467 each—bid "B", 696 each, (6) fin XM17 w/fin cont., bid "A", 1868 each—bid "B", 2784 each, (7) forward motor fairing, bid "A", 934 each—bid "B", 1392 each, (8) rocket motor XM37E3, bid "A", 2028 each—bid "B", 3024 each. Items 1 through 7 are to be solicited from current and/or prior producers and other qualified producers as deemed necessary by each Ordnance District to obtain adequate competition. This procurement is being synopsized for prime and subcontracting opportunities. Previous procurements of the above listed items have decidedly shown that the *Honest John* rocket maior components are of a complex nature requiring substantial know-how, initial investment and an extended period of preparation for manufacture. No security clearance will be required of the successful bidder or offeror. Specs and drawings for this procurement action are available at all U.S. Army Ordnance Districts. Item No. 8, rocket motor XM37E3, is being 100 per cent set aside for small business and is being synopsized for prime and subcontracting opportunities to concerns which are not on the current bidders list.


Circle No. 10 on Subscriber Service Card

# What Is Your WELDED DIAPHRAGM BELLOWS I.Q.?



## Take This 2 Minute "Refresher Course" For Better Bellows Performance

**1.** Can you depend on long operating life . . . into millions of cycles?
☐ YES ☐ NO

**2.** Can you depend on uniform performance from bellows to bellows?
☐ YES ☐ NO

**3.** Will welded diaphragm bellows give you a constant effective area over a large pressure range?
☐ YES ☐ NO

**4.** Can you count on excellent spring characteristics and pressure deflection curves from these bellows?
☐ YES ☐ NO

**5.** Will the welded technique reduce outgassing of evacuated and sealed assemblies?
☐ YES ☐ NO

**6.** Will you have bellows leak tightness to mass spectrometer sensitivity?
☐ YES ☐ NO

**7.** Can you obtain long stroke in a short package?
☐ YES ☐ NO

**8.** In floated instruments can you get large volumetric compensation in a small bellows envelope?
☐ YES ☐ NO

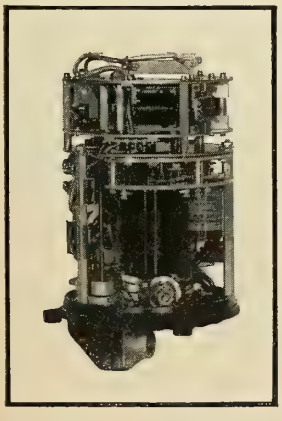
**9.** Will welded bellows withstand high pressures and temperatures?
☐ YES ☐ NO

**10.** Can these bellows be made to resist a wide range of corrosive elements?
☐ YES ☐ NO

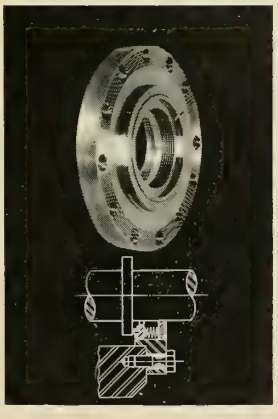
If you answered "yes" to all ten questions, your bellows IQ *is* high . . . as high as the performance you'll get with welded diaphragm metal bellows.

**METAL BELLOWS CORPORATION** designs and manufactures welded diaphragm bellows assemblies for a growing number of diversified applications — industries: A few illustrations are shown below.

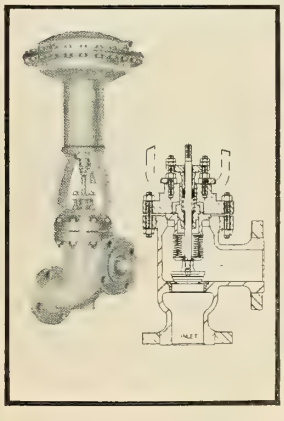
PRESSURE SENSING



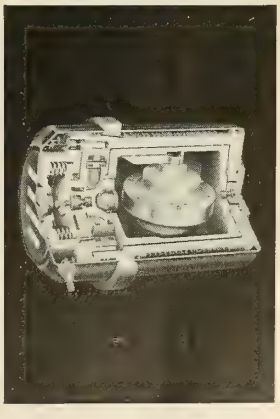
ROTATING SHAFT SEALS



VALVE SEALS



VOLUME COMPENSATOR



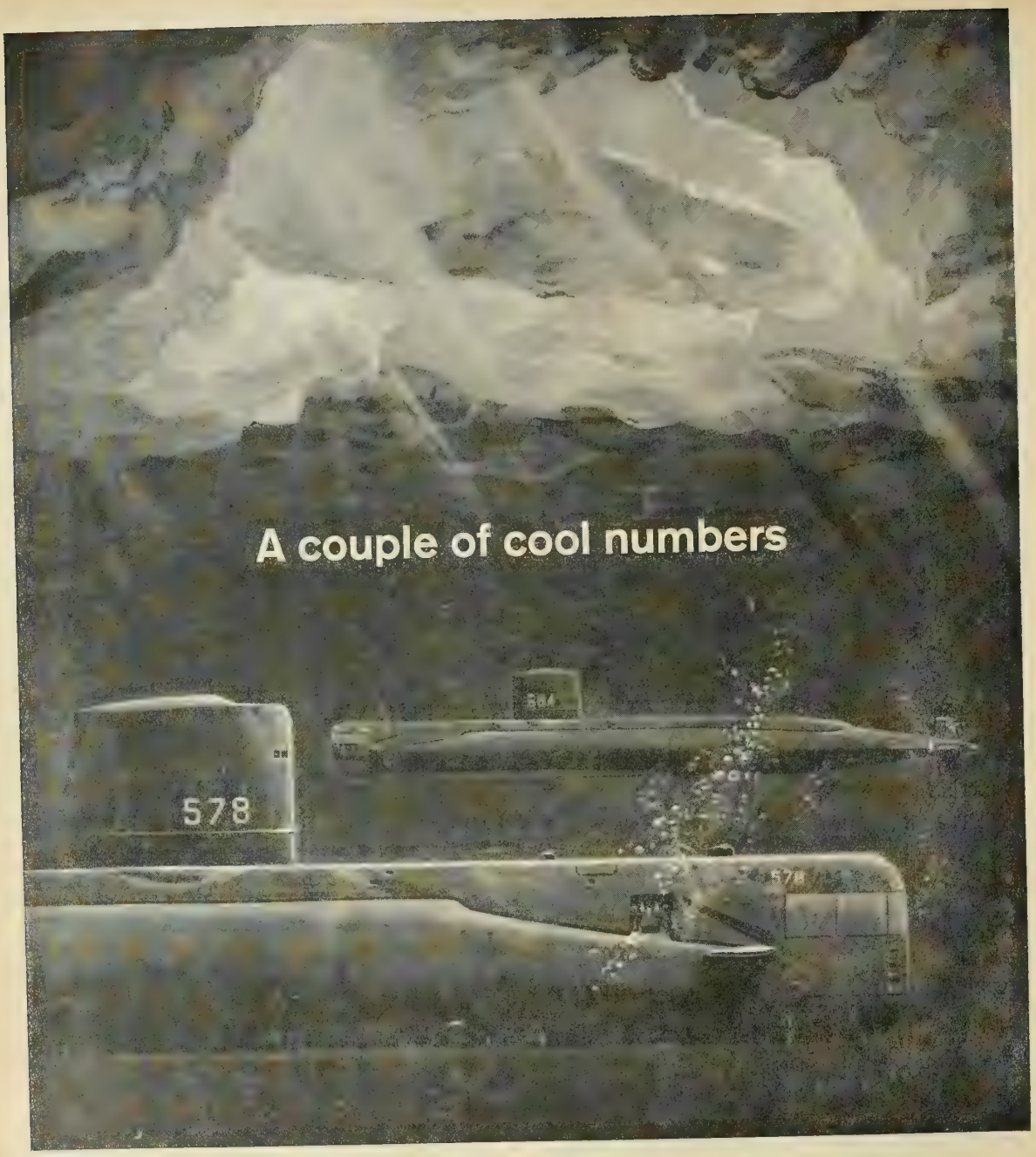
METAL Bellows CORPORATION

*Your inquiry on research, engineering and fabrication of welded metal diaphragm bellows is invited. Metal Bellows Corp. is set to serve you from East or West coast plants.*

1022

MICA LANE, WELLESLEY HILLS 82, MASSACHUSETTS • Pacific Division • Knapp St., Chatsworth (L. A.) California

Circle No. 22 on Subscriber Service Card




The *USS Skate* and *USS Seadragon*, in a cool job of precision navigation from opposite sides of the globe, have made a historic rendezvous under the Arctic ice pack—proving how advanced is this nation's undersea technology today. Sperry congratulates the commanders, crews and scientists of these nuclear submarines. Considerable Sperry gear was aboard both 578 and 584—and on each, a Sperry field engineer.

Missile-like guidance systems—Sperry SINS (for Ship's Inertial Navigation System)—measured everything from the drift of each sub to the earth's rotation during the voyage. The inertial heart of SINS—precision gyros and accelerometers—provided continual azimuth, position and vertical. SINS could not have been confused by known countermeasures.

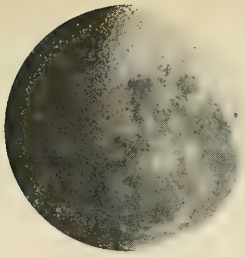
Mark 19 and Mark 23 Gyro-compasses provided precise supplementary navigational reference . . . Stabilized Periscope Sextants permitted star fixes when needed, with data computed automatically . . . and the subs had automatic course and depth controls, combined steering and diving instrumentation—all by Sperry and all contributing to the exacting feat.

Navy has done it again, and Sperry is proud to have played a key industry role. General offices: Great Neck, N. Y.

SPERRY
DIVISIONS OF SPERRY RAND CORPORATION



Circle No. 13 on Subscriber Service Card



Boeing has been awarded primary developmental, building and test responsibility for NASA's Saturn S-IC advanced first stage booster. Aero-Space Division's new Saturn Booster Branch has immediate, long-range openings offering professional challenge, rapid advancement and ground-floor opportunities to graduate engineers and scientists.

This new Saturn program is expanding rapidly, providing unique advancement advantages to properly qualified Structural Design, Electronics/Electrical, Propulsion, Aeronautical, Cyrogenics, Systems Test, Thermodynamics, Mechanical Design, Industrial and Manufacturing Engineers, as well as to Physicists and Mathematicians.

Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Boeing pays liberal travel and moving allowances to newly-hired engineers.

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn, and other missile and space programs at Boeing — including the solid-fuel Minuteman ICBM and X-20 (Dyna-Soar) boost-glide vehicle — are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

**BOEING**

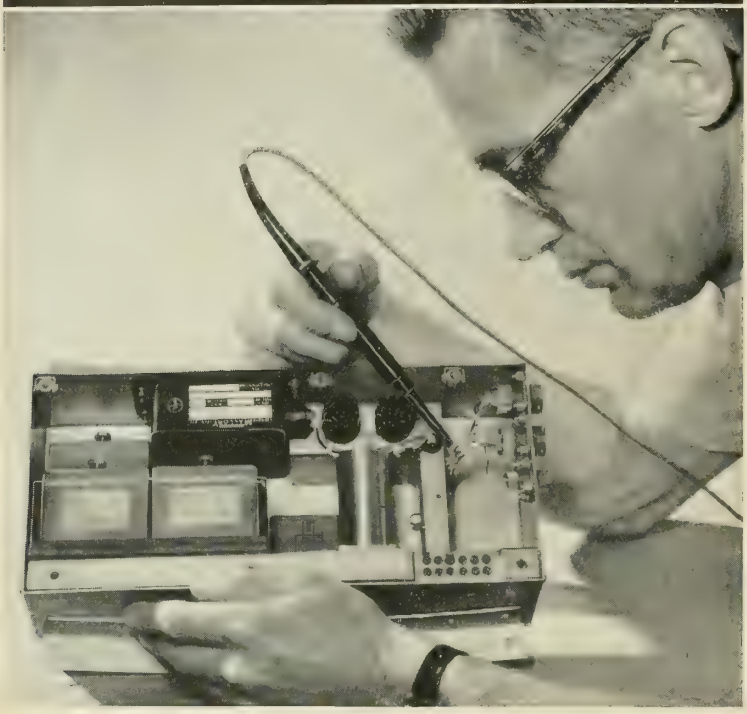
*Send your resume to Mr. R. R. Gregg, The Boeing Company, P. O. Box 26088 - MSB, New Orleans, La. An equal opportunity employer.*




**BOEING**

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Taber TELE-NEWS
about TELEDYNE® and TELEFLIGHT® pressure systems



## Taber Amplifiers ride Atlas in Aerospace Corp. conductivity test

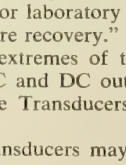
Employing three Taber Amplifiers, an experiment conceived by Aerospace Corporation for the U. S. Air Force rode an Atlas missile, successfully measuring, for the first time, electrical conductivity of ionized air during re-entry. The amplifiers increased and demodulated the signal from a sensing transducer, matching it to the input requirements of the telemetry system.

Aerospace writes, "Taber Amplifiers met our rigid performance specifications . . . performed properly during flight and are still being used for laboratory test purposes despite immersion in salt water for several hours before recovery."

Compact, lightweight Taber Amplifiers are reliable under extremes of temperature and vibration. Available to meet a wide range of AC and DC output requirements, they can be combined with Taber Strain Gage Transducers as compact pressure sensing packages.

Detailed, illustrated literature on Taber Amplifiers and Transducers may be obtained by mailing this coupon attached to your letterhead.

TO: TABER INSTRUMENT CORPORATION
AEROSPACE ELECTRONICS DIVISION SECTION 217
107 Goundry Street, North Tonawanda, N. Y.
Send detailed information on Taber Amplifiers and Transducers.



name _____ title _____
company _____ dept _____
address _____
city _____ zone _____ state _____

# –names in the news–

**H. Leslie Hoffman:** Founder and president of Hoffman Electronics Corp., Los Angeles, Calif., elected chairman of the board. **Stanley W. Horrocks,** formerly executive vice president of North American Aviation, Inc.'s Autonetics Div., named president.

**Stanley M. Smolensky,** formerly with Thiokol Chemical Corp. has joined NASA as Deputy to **Milton W. Rosen,** Director of Launch Vehicles in the Office of Manned Space Flight.

**Richard C. King:** Appointed coordinator, aerospace and defense projects for Kaiser Industries Corp., Washington, D.C.

**Robert E. Hull:** Elected vice president of engineering at Radio Engineering Laboratories, Inc., Long Island City, N.Y.

**Dewey Thiessen:** Promoted to chief engineer of Fairchild Stratos Aircraft-Missiles Div., Hagerstown, Md.

**Arthur E. Thake:** Elected vice president of manufacturing of Consolidated Vacuum Corp., Rochester, N.Y.

**Dr. J. M. B. Kellogg:** Named research advisor at the Los Alamos Scientific Laboratory, Los Alamos, N.M. **Dr. Richard F. Taschek** named head of the laboratory's physics division and **Dr. Louis Rosen** named alternate physics division leader.

**Harold S. Becker:** Appointed manager of Aerospace Corp.'s Special Vehicle Projects Office, Systems Research and Planning Div., Los Angeles, Calif.

**Ralph Wight:** Appointed operations manager of Fairchild Camera and Instrument Corp.'s Defense Products Div., Los Angeles, Calif.

**Eugene W. Murphy:** Appointed assistant director of public relations for Republic Aviation Corp., Farmingdale, N.Y.

**Saul Fast:** Named vice president and technical advisor of National Co., Inc., Malden, Mass.

**James A. Summer:** Elected a vice president of General Mills, Minneapolis, Minn.

**Joseph D. Hogan:** Appointed manager of materials for The Geraldines Ltd., Annapolis, Md.

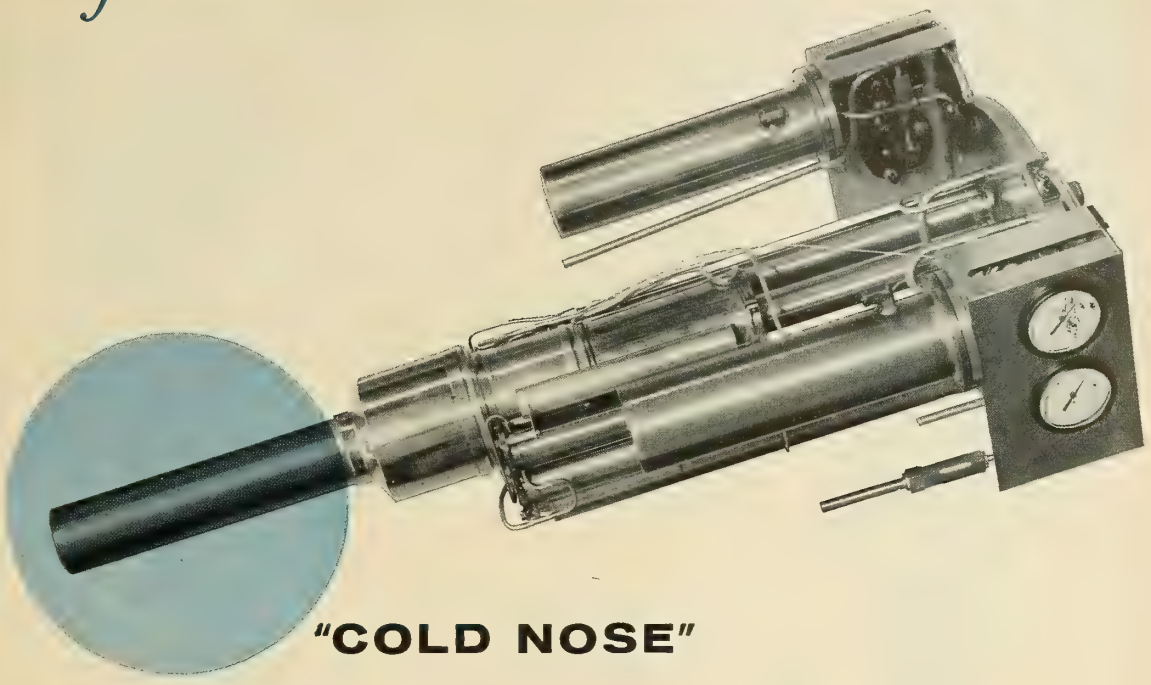
**William A. Buck:** Appointed manager of Marconi Instruments, Englewood, N.J.

**Dr. Paul R. Fuller:** Named chief of the behavior systems section of the life sciences department at Martin Co.'s Space Systems Div., Baltimore, Md.

**C. R. Bunch:** Appointed manager of Air Force Programs for the Garrett Corp., Los Angeles, Calif.

**Howard N. Sachar:** Appointed manager of international marketing for Thompson Ramo Wooldridge, Inc., El Segundo, Calif.

## ∫ INTEGRATED CAPABILITIES FOR SPACE-AGE CRYOGENICS



# "COLD NOSE"

The "cold nose" of this Air Products cryostat has achieved near-absolute-zero environments as low as 2.5°K (—455.2°F). Cryostat pictured is part of an Air Products closed-cycle helium refrigerator developed for Bell Telephone Laboratories under contract with the Army Ordnance Missile Command. The completely self-contained refrigeration system provides maser cooling without need for external supply of cryogenic liquids that boil away in open-cycle systems.

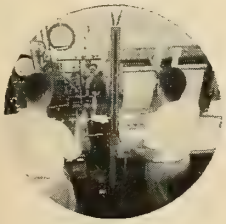
Today, Air Products manufactures a complete line of single- and multi-fluid cryogenic refrigerators. Applications range from the creation of ultralow-temperature environments for space chamber "cryopumping". . . to cryogenic cooling of masers, infrared detectors, superconducting magnets, computer memory planes, and other electronic sensing devices.

Miniaturization of components — pioneered by Air Products — makes possible the application of cryogenic electronics coolers where compactness and light weight are prime requisites. Ability to engineer standard and custom components into "critical-performance" systems gives added flexibility in meeting specialized requirements of industry and government customers.

Customers benefit, too, from Air Products depth of experience in all phases of cryogenics . . . from initial development and design through on-site operations of large-scale cryogenic production facilities.

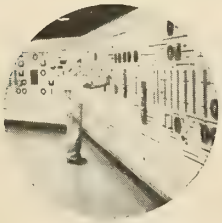
Whatever your requirements for cryogenic cooling, it pays to contact Air Products first.

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DEFENSE AND SPACE DIVISION


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**ADVANCED DESIGN RESEARCH (BS, MS, PhD).** Studies for advanced rocket systems to establish system concepts and optimize preliminary design criteria.

**MECHANICAL DESIGN RESEARCH (BS, MS, PhD).** Of materials behavior, exhaust gas control, insulation. Hardware feasibility studies for future systems.

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**COMBUSTION RESEARCH (MS, PhD).** Theoretical and applied studies of combustion process in rocket chamber under firing conditions.

**GAS DYNAMICS (MS, PhD).** Analytical and experimental studies of particle flow, nozzle efficiency, altitude performance parameters, thrust magnitude and vector control.

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**STRESS ANALYSIS (BS, MS, PhD).** Analysis of filament-wound pressure vessels and rocket motor components.

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**PROCESS ENGINEERING (BS, MS).** Design improved material handling, molding, tooling and process equipment for propellant and rocket manufacturing.

**TEST ENGINEERING (BS, MS).** Build and analyze static firing test stands and associated hardware. Recommend range handling and operating equipment including environmental test.

**ACOUSTICAL PHYSICS (MS, PhD).** Analyze behavior of burning rockets under various acoustical phenomena.

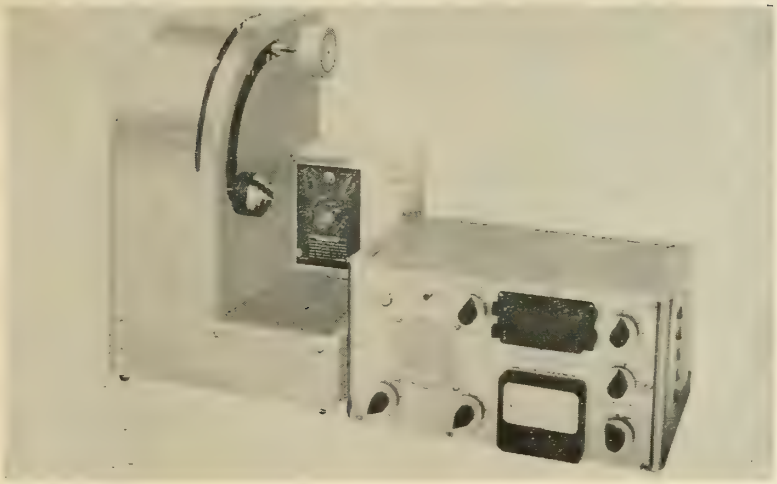
**DATA REDUCTION (BS, MS).** Prepare calculation systems for programming complex data into IBM 7074 computer.

**STATISTICS (MS, PhD).** Apply statistical methods to quality control, reliability, research test procedures and analyses of test data.

Write in confidence to: Mr. W. D. Linkenhoker, Dept. 3J-4

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## New Product of the Week: Electronic Bearing Analyzer

A device to electrically test sliding ring and self-aligning bearings has been developed by Bearing Inspection, Inc. The Model BA-20-2HV is designed to evaluate surface defects on raceways' rolling elements and operating characteristics of retainers and shields of completely assembled bearings.

The unit is applicable for either new bearing analysis or as an essential instrument for companies engaged in used bearing reclamation programs.

Dynamic analysis is achieved through three testing stations consisting of a go-no-go quality meter to evaluate the severity of a defect, an integral oscilloscope to determine the position of the defect and an audio signal system that provides constant radio monitoring through the testing operation.

The standard chuck is capable of handling 97% of all bearing sizes, from the smallest instrument type up to large jet engine sizes, either dry or lubricated, ball or roller. The drive unit incorporates a new suspension system for the motor and power transmission chain that provides exceptional damping and isolation properties to insure that only true vibration signals from the bearing being tested are transmitted.

Circle No. 225 on Subscriber Service Card

### Waveguide Switch

A latching-type waveguide switch requiring no holding current is available from Waveguide, Inc. The unit does not necessitate current to maintain either an open or closed position. Model W51AH2L is designed for X-band operation and is available in T-junction SPDT, as well as 4-post transfer versions.

A 30-msec. pulse of 900 ma. is required to open the switch, and a 10-msec. pulse of 900 ma. will close it. It exhibits excellent RF characteristics. Isolation is 55 db minimum, insertion loss is 0.1 db maximum, and VSWR is 1.05:1 for any 10% band.

Circle No. 226 on Subscriber Service Card

### Triple Conversion Receiver

A general-purpose triple-conversion radio receiver operating between 70 kilocycles and 30 megacycles in 15 band segments is available from Mackay Radio and Telegraph Co., subsidiary of International Telephone and Telegraph Corp. The Model 3010B is designed for use aboard ships, where vibration, atmospheric changes, and other severe environmental conditions exist. The unit provides reception of AM, CW, SSB, and FSK signals and may be operated down to 10 kilocycles with somewhat reduced sensitivity.

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### Liquid Gas Converter

Compact liquid gas converter units have been developed by Aro-Firewel to provide an energy source or pressure for many aerospace, industrial or laboratory applications, wherever compression or high-pressure systems are required.

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## Vacuum Booster

An ultra-high vacuum ion pump system, Ultek BoostiVac, capable of vacuums of 5 x $10^{-9}$ torr in 4 hrs. is being marketed by Ultek Corp. Complete freedom from oil contamination is achieved in the system, which is capable of 1 to 2 x $10^{-9}$ overnight without bakeout. The system is all electric in operation and eliminates the need for liquid nitrogen, water or air services.

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## Multi-Turn Pots

Any combination of two precision linear- or functional-output potentiometer elements, mounted in the same small case usually reserved for a single element, can be specified for use in multi-turn designs with the introduction of the Model 7810 Precision Potentiometer, made by Computer Instruments Corp.

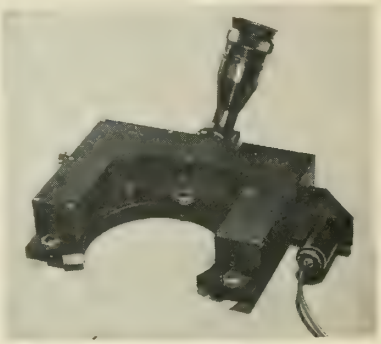
Model 7810's case can be as small as 1 5/16 in. long by 7/8 in. dia. All elements are made to customer requirements.

Circle No. 230 on Subscriber Service Card

## Arcmeter

The "Arcmeter," an optical angular measuring and calibration instrument used to pre-set or check out missile guidance equipment, digital shaft encoders, gyro test tables, and complicated indexing devices is available from David W. Mann Co.

The instrument is equipped with a 6-in. dia. precision-ruled glass circle. Each circle is an original ruling with an



angular accuracy to one second of arc, and is designed for simple mounting or integration in complex equipment to perform its measuring or calibration operation, and carries a built-in automatic correction mechanism for eccentricities of mounting. It also provides a direct read-out capability, eliminating any need for performing mental calculations in conjunction with its operation.

Circle No. 231 on Subscriber Service Card

## Miniature Slip Ring Assembly

A microminiaturized slip ring assembly featuring low noise and low torque is available from Slip Ring Co. of America for use with inertial navigation guidance systems. Designated SCA 1550, the capsule fully meets all requirements of MIL-E-5400C and MIL-E-5272-B.

The assembly measures only 0.250 in. diameter by 0.750 in. overall length. It includes 20 solid gold rings and 40 brushes with a stainless steel sealed housing and Teflon-insulated leads. The rotor in integrally molded and is mounted at both ends on precision bearings. Other specifications include 1 amp rating of all circuits and ability to operate in ambient temperatures ranging from −65°F to 350°F.

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# new literature

AN INTRODUCTION TO SOLIONS — An illustrated brochure available from Texas Research and Electronic Corp. covers the electromechanical principle of the solion redox system and describes the characterization of solion tetrodes and solion two-terminal devices. Applications notes and circuit design techniques are included.

Circle No. 200 on Subscriber Service Card

ROTARY SWITCH SELECTOR—A catalog containing 12 pages has been completed by Janco Corp. Over 25 standard and special application switches are pictured and described. The catalog also gives general information on Janco quality control, operational and environmental data.

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B-58 BOMB NAV SIMULATOR, designated AN/ASQ-T2, uses hemispherical recorders to trace "flight." Precise position is determined by celestial navigation using six stars and the sun together with position verification from a land-mass radar system. The Curtiss-Wright simulator provides stored radar data for four million sq. miles of area with sufficient resolution to detect landmarks as small as 200 feet.

TEMPERATURE CONTROL UNIT —An illustrated bulletin released by Mokon Division of Protective Closure Co., Inc., presents an improved control unit for regulating plastic injection mold temperatures through a single dial. Operating features are described and illustrated to show how the compact Mokon system can be used to circulate water through the mold, heating and cooling it as required (40-250°F).

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ROTARY ACTUATORS—Capable of several turns output and providing torque from 10 to 1,000,000 in.-lbs., rotary actuators are described in detail in a brochure available from Graham Engineering Co. Hydraulically or pneumatically powered, Rota-Cyl rotary actuators attach simply onto new products or existing installations. Size and weight are ⅓ that of previously available rotary actuators or cylinder-type devices. Control schematics for pneumatic or hydraulic operation are included, together with essential application information.

Circle No. 203 on Subscriber Service Card

SUBMINIATURE POTENTIOMETERS—A technical data sheet on Daystrom 302 series squaretrim (R) subminiature trimming potentiomenters provides complete specifications covering these tiny ½-in. sq. units. With a range of 10 ohm to 65 kilohms, operating temperature range of −55 to 150°C, a power rating of 1 watt in still air and meeting or exceeding all applicable MIL specs, the side-pin potentiometers in the Daystrom Squaretrim 302 series are used for the delicate adjustment of computer, control, telemetering, missile, and other critical military and industrial electronic circuits.

Circle No. 204 on Subscriber Service Card

CONTACT RELAYS—An eight-page catalog describing a series of mercury-wetted contact relays is available from Potter & Brumfield Div. of American Machine & Foundry Co. Design details of the mercury-wetted contact arrangement, and electrical and physical performance characteristics featured in the catalog are helpful in determining a wide variety of application possibilities for mercury-wetted contact relays, designated the JM Series. Also included are formulas with which to calculate contact operating characteristics, stroboscopic photo-drawings showing the action of mercury on contact surfaces, and tables of resistance ratings and values of maximum voltages.

Circle No. 205 on Subscriber Service Card

COMPUTING SYSTEM—A 16-page brochure entitled "A Technical Introduction to the Bendix G-21 Computing System" is available from the Manager of Military Applications, Bendix Computer Division. A maximum unit of the "super computer," made of basic G-20 components, offers a total of 81,000 words of core memory (up to 57,344 words of system-common core memory and up to 8192 words of core memory assigned to each processor).

Circle No. 206 on Subscriber Service Card

HEAT RADIATORS—Technical Data Sheet 1002 describes the 4AL series of heat radiators, developed by the Industrial Div., the Birtcher Corp., for mounting high-powered semiconductors where 50, 100, 200 and higher wattage dissipation is required. Included are detailed drawings of radiators and 12-hole pattern layouts, qualification tests with chart of watts dissipated in relation to temperature rise, and a list of distributors.

Circle No. 207 on Subscriber Service Card

SCIENTIFIC AND ANALYTICAL INSTRUMENTS — The Scientific Instruments Division of Engis Equipment Co. has published a listing of instrumentation, publications and books. It features particularly Hilger & Watts scientific and analytical instruments for use wherever the electro-magnetic spectrum is the basis for analysis and research. Publications available include descriptions and specifications of such major equipment as atomic absorption, color-meter, etalons, gratings, interferometers, lamps and light sources, monochromaters, polarimeters, seismometers.

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**PROJECT IN POINT:**

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*Project in Point:* Today at Carswell and Bunker Hill Air Force Bases, B-58 navigators are being trained by the most sophisticated BOMB NAV simulators in existence. They were designed and manufactured by Curtiss-Wright under contract to General Dynamics/Convair.

The skills in systems and products developed by this and other programs are now being applied to the USAF C-141, the Lockheed turbofan freighter. Curtiss-Wright will produce fully digital simulators for flight crew training—a major step forward in this field.

These advanced activities have created immediate opportunities at Curtiss-Wright Electronics Division for solid state circuit designers, digital computer programmers and others experienced in the application of real-time digital computation to the most challenging problems in simulation.

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## space suit materials

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## mechanical engineers

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**National Power Conference, (ASMW-AIEE),** Lord Baltimore Hotel, Baltimore, Md., Sept. 24-26.

**Thirteenth International Astronautical Congress, American Rocket Society,** Sofia, Bulgaria, Sept. 24-28.

**Space Power Systems Conference, American Rocket Society,** Miramar Hotel, Santa Monica, Calif., Sept. 25-28.

**Symposium on the Physics of Failure in Electronics, sponsored by Rome Air Force Development Center, USAF Systems Command and Armour Research Foundation,** Illinois Institute of Technology, Chicago, Ill., Sept. 26-27.

**Symposium on Dynamic Behavior of Materials, sponsored by the University of New Mexico and Rocky Mt. district of American Society for Testing and Materials,** Statler Hilton Hotel, Los Angeles, Sept. 30-Oct. 5.

**Third Annual Aerospace Fair,** Vandenberg Air Force Base, Calif., 10 a.m. to 4 p.m., Sept. 20. (Open to the public.)

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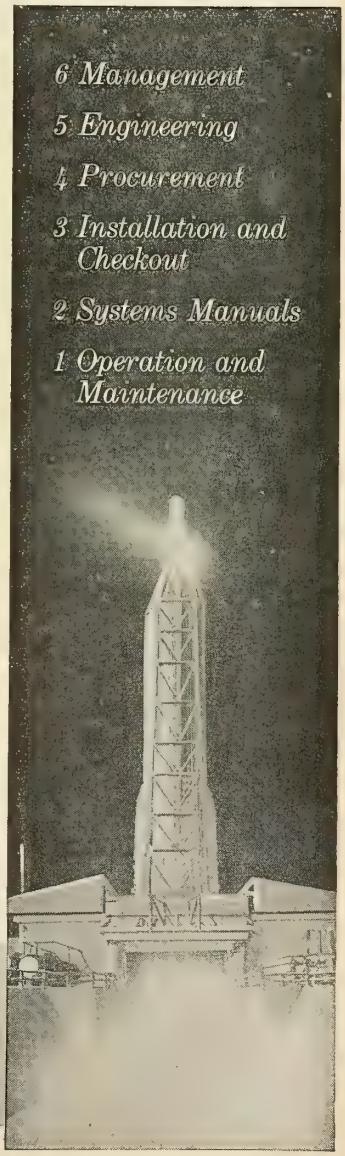
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# Move Over, Mr. Blough

PRESIDENT KENNEDY'S sledge-hammer blow at missile/space industry firms in the current labor dispute has faded his attack on U.S. Steel to the proportion of a faint slap on the wrist.

A naked display of Presidential power has put an end to any semblance of fair negotiation in the dispute between four industry firms and the UAW-IAM labor combine. The President has chosen as the point for his intervention an issue which again will not set well with business. It should be equally abhorrent to knowledgeable labor leaders.

His forcing of a union shop on industry firms is unsound labor practice. It is not the union shop we object to; it is the crass action of the President.

With one deft phrase, he has wiped out weeks of negotiating and handed to the unions what they have not been able to achieve in years of careful collective bargaining by both sides.

The President's statement that, if the companies refused to accept the advisory board's union shop decision and a strike followed, "the responsibility would be very clear, I think, to the American people," was crushing to industry management.

This is not labor negotiation. It is imposition of labor demands by Presidential fiat. It destroys the delicate balance of power which is at the heart of all successful collective bargaining.

President Kennedy is using the threat of American public opinion to force a settlement on the companies which the unions themselves have not been able to obtain. We do not believe the American public is in accord with such flagrant tactics.

The President is saying to industry management, in effect, "Accept the settlement we want or we will see to it that the guilt is placed squarely on your heads."

That is the act of a dictator, however benign.

But the full brutality of the act is not apparent even from the statement wielding the threat of public opinion. The companies involved all are missile/space contractors. Their dependence on government goodwill is heavy. To risk the President's displeasure by not acceding to his demand is to risk a black-listing.

The threat of a massive public relations onslaught such as the one which forced U.S. Steel's Roger Blough to capitulate, combined with the threat of financial disaster through loss of contracts, is the strongest use of Presidential force against business to date.

The action of Lockheed Aircraft Corp. in rising immediately to oppose the President on the issue is to be warmly commended in these circumstances. It is more than a display of healthy self-interest; it is an act of bravery in support of the industry.

Lockheed has been the only one of the four firms to go publicly on record with a vigorous defense. The President's demand brought a strong retort from Lockheed Chairman Courtlandt Gross which termed both the advisory board report and the Kennedy comment "not in the public interest."

Chairman Gross suggested the President had violated the intent of Congress that free collective bargaining be the approved way to settle labor disputes. He also was quick to point out that more than half of Lockheed's California employees are not union members.

The Lockheed reaction is even more impressive when judged in light of this fact—since the advisory board's recommendation of a vote on a union shop may still leave Lockheed without a union shop.

WE ADMIRE guts and, in this case, the industry most certainly has looked to Lockheed for leadership. The remainder of the industry—for its own preservation—should take an equally strong stand, whether among the four companies presently threatened or not. The time to take that stand is now.

The President did not, in the U.S. Steel case, show any reluctance in using the threat of defense contracts to force his desires on the steel companies. He undoubtedly would not hestitate to do it again. As long as this threat is allowed to go unchallenged, the missile/space industry will be a captive of Presidential whim. The only way to fight is to fight. For the remainder of the industry to allow Lockheed to carry the battle alone is cowardice.

The alternative may be seen someday in advertisements which carry the tag lines, "An Equal Opportunity Employer, No U.S. Steel Used in This Product, Built in a Union Shop."

Granted, it is difficult for this industry to fight the government for freedom in this and many other instances. If it does not draw the line somewhere, if it continues to allow the government to dictate unrealistic terms in labor contracts and in defense contracts, it is not deserving of sympathy.

We care not whether union shops are good or bad for the industry. That is for the labor and management segments of the industry to work out freely at the collective bargaining table. But we do care when we see the industry we serve abused by dictatorial action—from anyone.

**William J. Coughlin**




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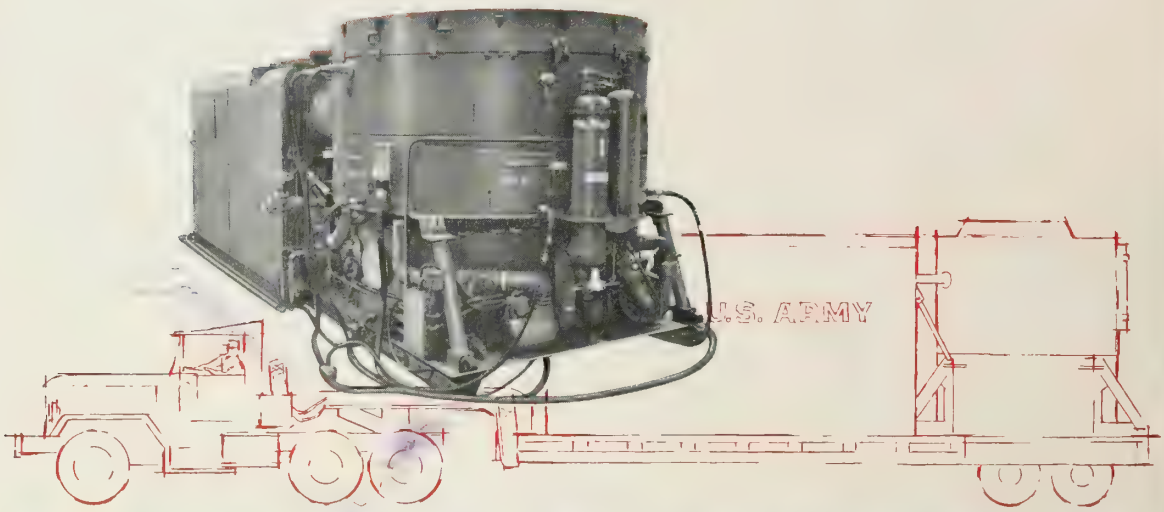
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OCTOBER 1, 1962

# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

OCT 1962

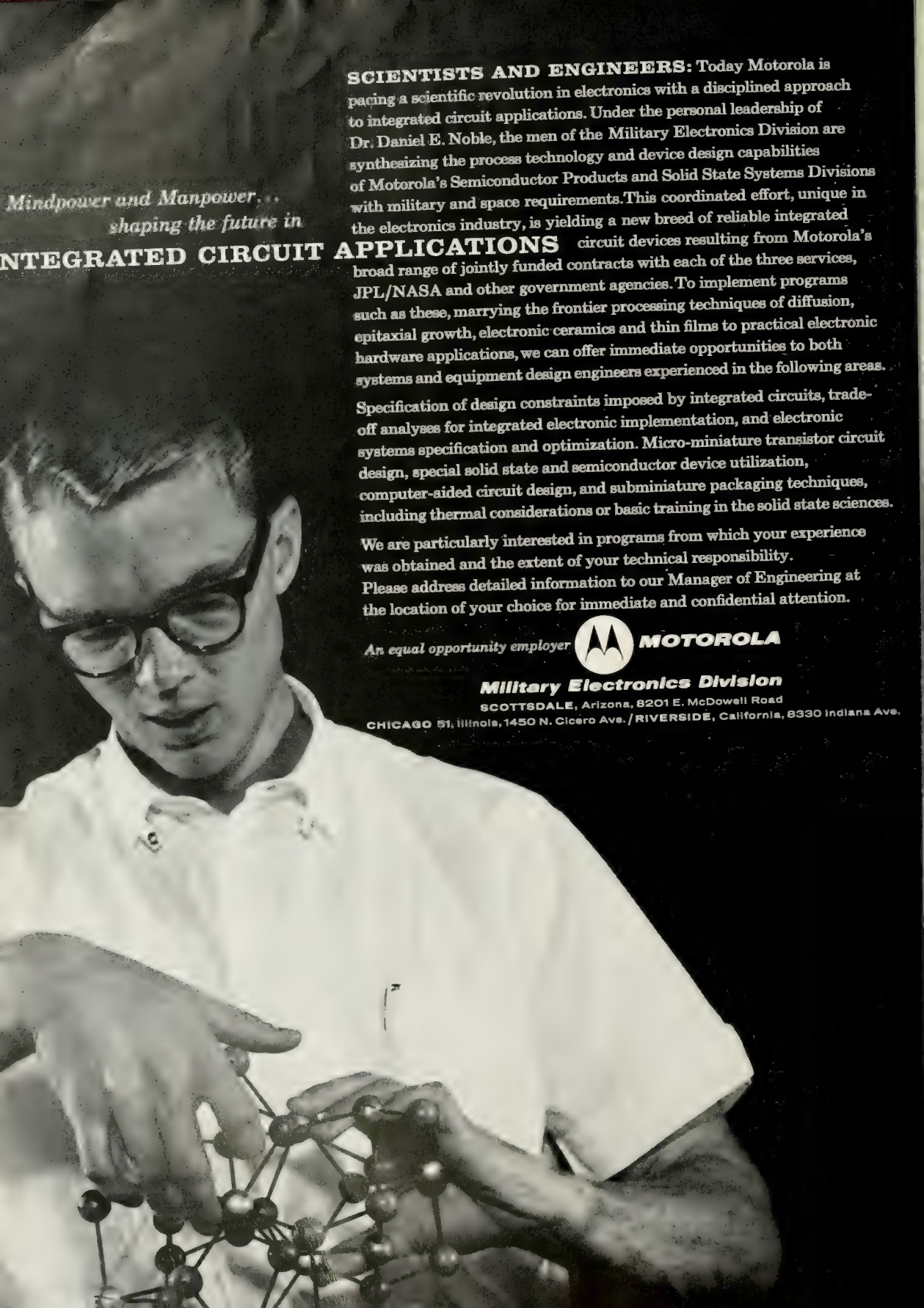


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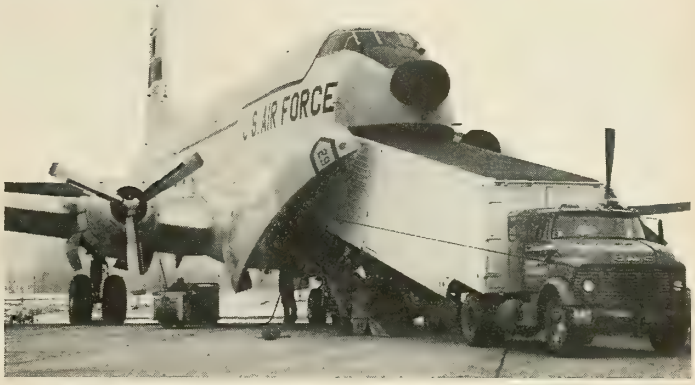
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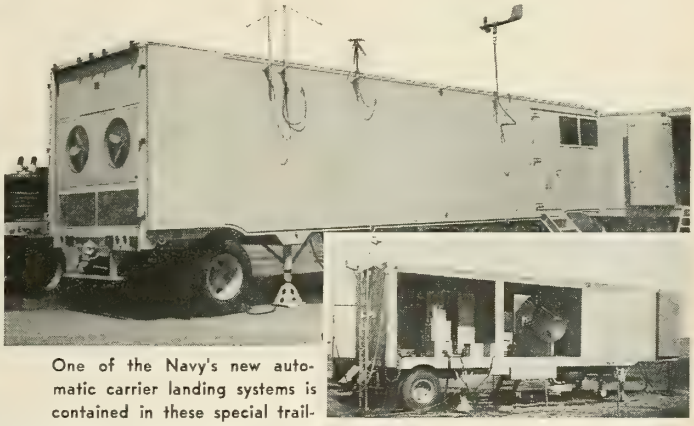
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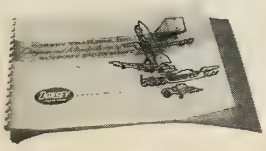
Successful completion of an impressive list of projects for the armed services and prime contractors proves Dorsey's ability to produce trailers for electronics installations as well as for the safe transportation of delicate cargo. Our Special Products Division engineers bring to initial-stage conferences broad experience in special-feature design as well as a valuable knowledge of factors affecting performance, production time and cost. This division is available for complete R & D assignments or to adapt existing designs when feasible.



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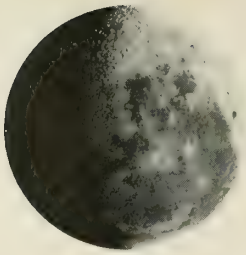
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 14 October 1, 1962

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## THE COVER

*Solar-lunar eclipse photos, such as this one taken by scientists from the Air Force Cambridge Research Laboratories' Office of Aerospace Research and Lockheed-California Co., will aid Moon studies.* *See p. 10.*

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# letters

## 'The Big Knife'

*To the Editor:*

The editorial entitled "The Big Knife" (M/R, Aug. 20, p. 46) if heeded, is beyond a doubt the most important printed page of the year.

If your recommendation in Item No. Seven is not followed, in a few more years every aerospace firm can take down its company sign and replace it with a four-letter sign: "NASA."

America cannot survive without private industry.

Though you may feel alone in your outspoken editorials, do not waver from your course of calling a spade a spade. Maybe someday those management personnel in the very industries you are trying to help will regain their courage and equilibrium and speak forth their long-held opinions.

P. J. Grubl
Aerospace Industry Engineering Supervisor
Lancaster, Calif.

## Hot Water Rockets

*To the Editor:*

Pleased to read your article "Steam Rocket Successfully Tested" (John Judge, M/R, Sept. 10, p. 24). The article covered many points in the basic design of hot water rockets.

Considerable work was achieved on hot water rockets with over a hundred firings at the University of Santa Clara approximately five years ago. The Santa Clara rocket used an electrical immersion heater. Hot water was then expanded through an aluminum nozzle to steam, thus creating a thrust.

M. A. Vonnegut
United Technology Corp.
Sunnyvale, Calif.

## Vostok Controversy

*To the Editor:*

Most calculations made are necessarily somewhat inexact, Mr. Saunders B. Kramer observed in his discussion of *Vostok III* and *IV* rendezvous possibilities (M/R, Sept. 3, p. 7). One may wonder how inexact Mr. Kramer's calculations have been, since his findings that "the angular separation of the orbits was two minutes of arc" seem to be off the mark by a factor of 60 or more.

Disregarding the discrepancy between *Pravda's* and GSEC's, orbital periods of the two satellites, and using the *Pravda* figures as Mr. Kramer did, I found that after 16 orbits *Vostok III* was still 28.8 minutes flight time away from the longitude of its launching pad. At about that time *Vostok IV* was launched.

Allowing for several minutes elapsed time between launch and injection of *Vostok IV*, but definitely much less than almost half an hour, I do not see how the angular separation of the two orbits could have been less than at least several degrees of arc, resulting in a minimum distance considerably greater than the one calculated by Mr. Kramer.

I wonder how Mr. Kramer calculated the angular separation of the two orbits. I am afraid he overlooked some principles of celestrial mechanics, and forgot to note that while *Vostok III* made its rounds, our good Earth did not stand still.

May I assume that the two minutes of arc separation he used as the basis of his calculations was the two minutes of arc difference between orbital plane inclinations? If so, then he indeed assumed that the Earth stopped its spin during the *Vostok III* flight. And it is that spin which determines the position of the orbital planes of Earth satellites in the solar system. In this respect the orbital inclination was a factor of secondary importance.

J. A. Redeker, Science Editor
Algemeen Dagblad
Rotterdam, Netherlands

## Pro Polaris

*To the Editor:*

In your issue of Sept. 10, under "Letters" (p. 7), there was a short plea for critical examination of the *Polaris* weapon system . . . questioning whether this system, or any system so conceived and so dedicated, could long endure.

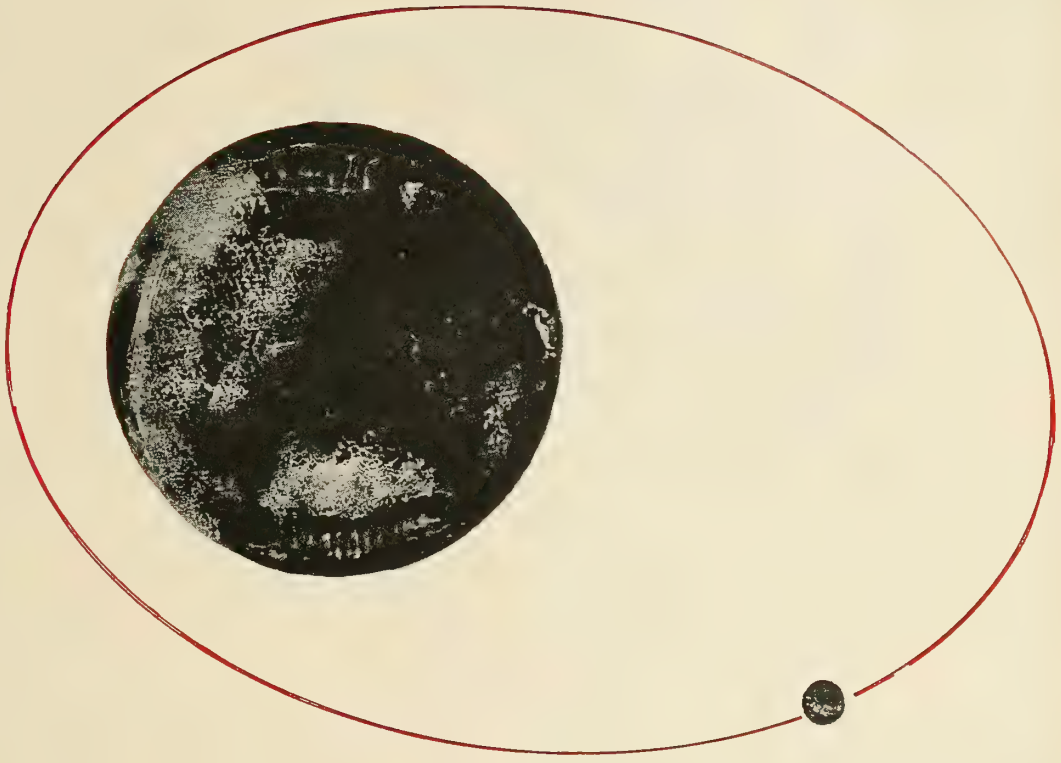
As one also interested in this system, I would like further information concerning the "anti-weapon of this weapon system" which "will make it obsolete before the full fleet is developed."

The Navy has stated that *Polaris* submarines are already on patrol. The reaction to this knowledge from our potential enemy . . . makes it evident that they do not consider the *Polaris* threat inconsequential. This conclusion is reinforced when we read (in the current issue of Jane's FIGHTING SHIPS) that the Soviet Union is increasing its anti-submarine warfare efforts. (Were its existing capabilities inadequate?)

The Navy is acutely aware of the fact that our country may soon be threatened by missile-firing submarines. Twenty years ago tankers, cargo ships, and troopships were submarine targets. Today's submarine targets are Chicago, St. Louis, Denver. ASW is, consequently, our Navy's most urgent effort. This is because our Navy is not the only one which likes to play with this "toy" referred to by your correspondent.

If he, or indeed any reader or writer of your splendid publication has particulars of any weapon system offering a high probability of detection, classification, localization and destruction of enemy submarines *before* they release their weapons, then I beseech him, as a fellow American, to help our Navy in its mission.

John H. Bothwell
Commander, U.S. Navy
Tactical Group, U.S. Fleet Anti-Submarine Warfare School
San Diego, Calif.



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# The Countdown

## WASHINGTON

### Solids Decision Still Pending

Decision still has not been made on the Air Force big solid booster program. NASA and DOD are unable to agree on the size of the program. DOD, with limited funds available, is reluctant to endorse the $100-million project backed by NASA. Issuance of requests for proposals depends on how quickly the dispute is settled.

### Minuteman Reaction Time Beats Name

First official disclosure of the reaction time for AF's solid-fueled *Minuteman* missile came from SAC Commander Gen. Thomas S. Power at the Air Force Assn. convention. The hardened, dispersed *Minuteman* can be fired in 32 sec., according to the general.

### Relay Follow-on Is Held Up

NASA will delay further development of the *Advanced Relay* spacecraft until sometime next year. Space agency officials want to study results of the first *Relay* launch later this year. They also hope to benefit by technical fallout from the Hughes *Syncom* communications satellite system.

### Approval of NASA Budget Delayed

House-Senate wrangling over civil defense is holding up approval of NASA's Fiscal '63 budget. Both houses have agreed, however, on the final budget figure of $3,674,115,000. This includes almost $2.9 billion for R&D and $776 million for construction.

### U.S. Lacks Tracking Capability

The U.S. SPADATS tracking network cannot pick up a Soviet satellite until at least the third or fourth orbit. An Air Force admission that the U.S. lacks a first-orbit tracking capability has been confirmed by DOD officials.

### Shillelagh Testing Is Under Way

Latest tests of the Aeronutronic *Shillelagh* anti-tank missile at White Sands Missile Range have drawn high praise from Army officials. A lightweight infantry version of the system may be in prospect.

### NASA to Award Apollo Oxygen Contract

Research contract for study of various oxygen and other gas mixtures for the *Apollo* environmental system is to be awarded shortly by NASA. Previous studies used volunteers breathing pure oxygen for two to three weeks while performing various tasks in a space simulator. Early results have indicated serious chemical changes in subjects' blood cells.

### Davy Crockett Joins Seventh Army

The Seventh Army in West Germany now has its full complement of nuclear-armed *Davy Crockett* weapons. The weapon's deployment to battle group level, begun last year, was completed several months ago.

### Now It's a TX-15?

Two of the six test pilots named to fly the *X-20* are scheduled for early flights in the *X-15* to gain experience in the air-launch technique that will be used for initial *Dyna-Soar* tests.

### Army Still Looking at Missile A

An Army requirement still exists for a short-range, battle-group missile system. Decision on the weapon, commonly referred to as *Missile A*, has been put off until results of *Missile B* development are known.

### NASA Seeks Recruiting Help

NASA officials are scheduled to meet this week in Washington with representatives of two firms to be used in recruitment and evaluation of top management personnel for the Office of Manned Space Flight. Twelve firms were evaluated before the decision was made in favor of Geo. Fry and Associates and Ernest Loen and Associates.

## INDUSTRY

### Lockheed to Develop GAR-9 Motor

Lockheed Propulsion Co. has received an initial contract of more than $500,000 from Hughes Aircraft for development of a solid rocket motor fuel for the advanced *GAR-9* air-to-air missile. LPC effort will be directed toward provision of superior performance over a wide temperature range. Firm has been conducting test firings with solid propellants for more than a year in an environmental range of nearly 300 degrees.

### Early Firing Set for Titan Strap-on

United Technology Corp. says the first complete 120-in. strap-on solid booster for *Titan III* will be fired approximately six months after final contract go-ahead is received. Design calls for thrust of more than one million pounds.

### Gyro Breakthrough Reported by Westinghouse

Westinghouse scientists claim a breakthrough in development of the first solid-state gyroscopic instrument. A thin-wall, pressed barium titanate cylinder only ½-in. long and ½-in. in diameter, the device requires less than 0.001-watt power. A twist or radial motion is obtained by exciting the suspended cylinder with a very small high-frequency voltage. This back-and-forth radial motion replaces wheel rotation in conventional gyros and permits detection of extremely slow drift rates.

### Minuteman Carrier Too Costly

A recent Boeing proposal for a lengthened and expanded fuselage version of the KC-135 to carry the *Minuteman* system complete with transporter and erector has been turned down by the Air Force. Reason: A $9-million-per-plane price tag.

## INTERNATIONAL

### MRBM Under NATO Discussion

Requirement for a medium range ballistic missile (MRBM) is now under discussion by the NATO council. Outlook is not bright for the system—long advocated as a NATO weapon by retiring Gen. Lauris Norstad. European members are reluctant to share development costs and the U.S. is unwilling to foot the total R&D bill.

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COMPLETEST

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STANDARD & CUSTOM. Genisco's extensive line includes dual tables, precision units, large production centrifuges, and R&D units not shown here. Custom equipment also available. Write for details.

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## NATO Missiles for Crete

West German and American forces in Europe are expected to be the main users of the new $50-million NATO rocket base to be built on Crete by 1965.

Plans call for four missile battalions to undergo one-month training at the base simultaneously. About 1000 NATO country trainees will be in Crete at any one time all year round.

Initially, the Crete center will be used to train Allied forces in the use of surface-to-air missiles. A sea zone 20 miles by 80 miles to the north of the island will be closed to navigation when the missile base becomes operational.

Ground and air-launched drones will be used as targets. Radar system for the missile range is to be installed on a tiny Aegean Sea island named Dia, north of Crete.

A high-ranking Greek Defense Ministry team sponsored by AGARD (NATO Advisory Group Aeronautical Research and Development), now is in the U.S. to tour existing surface-to-air missile training facilities.

The team will examine and investigate surface-to-air missile training systems and equipment compatible with Crete's NAMFI, (NATO Missile Firing Installation) range. Emphasis will be on the study of target range instrumentation, control, safety and costs in the *Nike-Ajax, Hercules* and *Hawk* missile systems.

Available information from Paris indicates that AGARD already has chosen the Ryan *Q-2 Firebee* target for NAMFI range use. It is expected that excessive target-missile expenditure will be alleviated through use of simulators.

## Novel Method Measures Moon

The Moon's true shape will be learned by a unique experiment involving a solar eclipse photographed July 31 *(see cover)* from a site about 125 miles southeast of Dakar in the West African Republic of Senegal.

Results of the experiment are expected to furnish data for man's landing on the Moon. An average altitude of lunar "sea level" may be established and lunar gravity effects may be learned more precisely—vital information for planning lunar landings and calculating lifetimes of lunar orbiters.

The photographs were taken dur-

ing the 3½ minutes the Sun was framing the Moon with an annular ring. They will be analyzed with the aid of a microdensitometer, which is expected to detail the Moon's rough rim to an accuracy of 1200 ft. The experiment was accomplished by scientists of the Air Force Cambridge Research Laboratories (Office of Aerospace Research) and the Lockheed-California Co.

Clouds obscuring the onset of the eclipse for two hours put the experiment in doubt. Fortunately, they parted briefly and in time for the U.S. team to get its data.

Not so fortunate was a Soviet astronomical team which reportedly was rained out in the Republic of Mali, about 400 miles from Dakar.

Two complete optical systems were used to photograph the eclipse. In the first, a 17-in. diameter optical flat mirror, on loan from Mt. Wilson-Palomar Observatory, reflected the Sun's rays to a concave 12¼-in. diameter mirror with a 57-ft. focal length. A lensless K-22 aerial camera was used to photograph the 6¼-in. solar-lunar image on film every two seconds.

Backup system included a 12-in. primary flat mirror loaned to the expedition by astronomer Ray Ensign of Fullerton, Calif., an 8½-in. concave mirror with a 26-ft. focal length, and a K-24 aerial camera that photographed a 3-in. image three times each second.

## Kennedy Defends Labor Stand

President Kennedy defended the union shop recommendations of his labor advisory board last week as necessary to maintain peace in the vital missile/space industry.

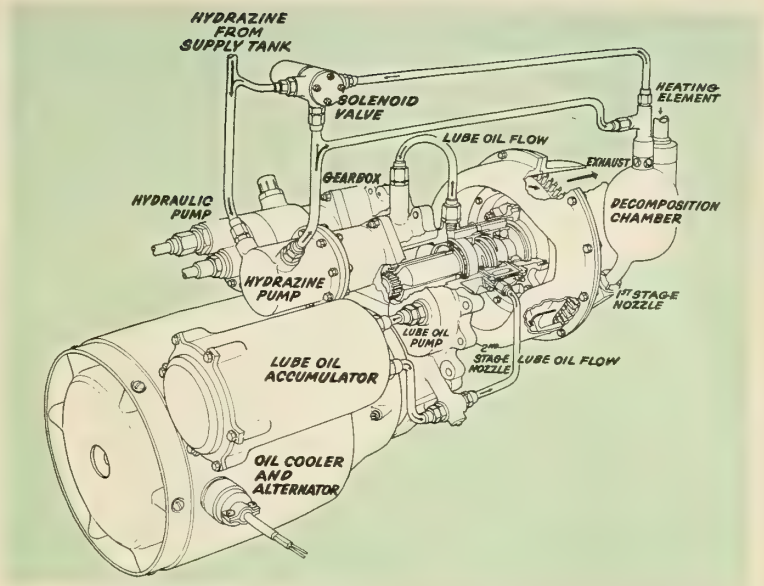
Commenting on the unpopularity of his stand with industry leaders, the President emphasized at his press conference the dependence of missile/space firms on government contracts.

He asserted that any wage increases will be paid for by the government while any program delays will be paid for "by the American people."

The President pointed out that the union shop has been accepted for years in such industries as automotive and steel.

## NASA to Study Radiation

A four-stage sounding rocket—carrying two experiments for God-


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*PHOTO SHOWS Bullpup missiles mounted on wingtips of British Navy Scimitar during flight tests. NATO will manufacture Bullpups in Europe under agreement signed last week with Martin Co. All components for the NATO missile will be European-made.*

dard Space Flight Center and the University of Minnesota—will be launched by NASA this month or next to determine the strength of the radiation belt created by the July 9 U.S. high-altitude nuclear test.

The still-to-be-selected sounding rocket will be launched from either Wallops Island, Va., or Point Arguello, Calif. Because of the lead time involved, the flight probably will not take place until November.

## Shots of the Week

• A *Minuteman* missile closely resembling operational configuration of the solid-fueled ICBM was successfully fired from its underground launch pad at Cape Canaveral Sept. 19. The flight followed an earlier success the day before (M/R, Sept. 24, p. 10).

• Although its second stage failed to burn for the programed time, fourth test of the air-launched *Skybolt* missile was labeled by Air Force as "95% successful." The missile, which fell far short of its planned 900-mile flight was launched over Cape Canaveral Sept. 25 by a B-52G from Eglin AFB, Fla. Telemetry data is being analyzed to determine cause of the failure.

Test objectives included check of propulsion, staging and autopilot. It was disclosed that failure of the third *Skybolt* launch on Sept. 13 has been attributed to the fact that the programer ordered separation instead of first stage ignition. Missile was destroyed by the range safety officer after the second stage ignited.

Fifth *Skybolt* launch, scheduled within a month, will be the first test of the Northrop stellar inertial guidance system (M/R, Sept. 17, p. 11).

• An Army *Redhead/Roadrunner* successfully completed its first low-level flight Sept. 18. The target missile—developed by the Columbus Div. of North American Aviation—flew at about 500 feet over the test range at Holloman AFB, N.M.

• A new three-stage *RAM B* rocket—developed by Ling-Temco-Vought—was launched last week from Wallops Station, Va. Eleven seconds after second stage ignition all contact with the vehicle was lost. No explanation of the Sept. 22 failure was available from NASA. Officials said the rocket is 41 ft. long, solid fueled.

Project RAM (Radio Attenuation Measurement) is designed to provide information on communication blackout during space vehicle re-entry.

• Two capsules ejected from an *Atlas F* Sept. 19 (M/R, Sept. 24, p. 10) were successfully recovered from the Atlantic Ocean the same day, AF announced. In addition to the two camera-carrying capsules, a data cassette from the re-entry body also was recovered.

## Propulsion Meet Draws 600

A capacity registration of more than 600 scientists and technical managers is expected at the Third Symposium on Advanced Propulsion

Concepts meeting in Cincinnati, Ohio, Oct. 2-4.

Sponsored jointly by the Air Force Office of Scientific Research and General Electric's Flight Propulsion Div., the symposium will mark the 20th anniversary of jet flight, with papers delineating propulsion state-of-the-art and future plans: nuclear and electrical propulsion, supersonic combustion, ramjets, large rockets, space-power sources and high-energy propellants.

MISSILES AND ROCKETS will present awards to authors of the three papers that a panel of program chairmen and AF scientists judge to be outstanding contributions to the propulsion art.

## S-3A Launch Scheduled

NASA will attempt this week to launch an *S-3A* energetic particle satellite.

The flight will be made from Cape Canaveral with a *Delta* launch vehicle no earlier than Oct. 2.

## New IAF Members Named

The Institute of the Aerospace Sciences and the Hungarian Astronautical Society became members of the International Astronautical Federation during the organization's 13th annual meeting Sept. 24-28 at Varna, Bulgaria.

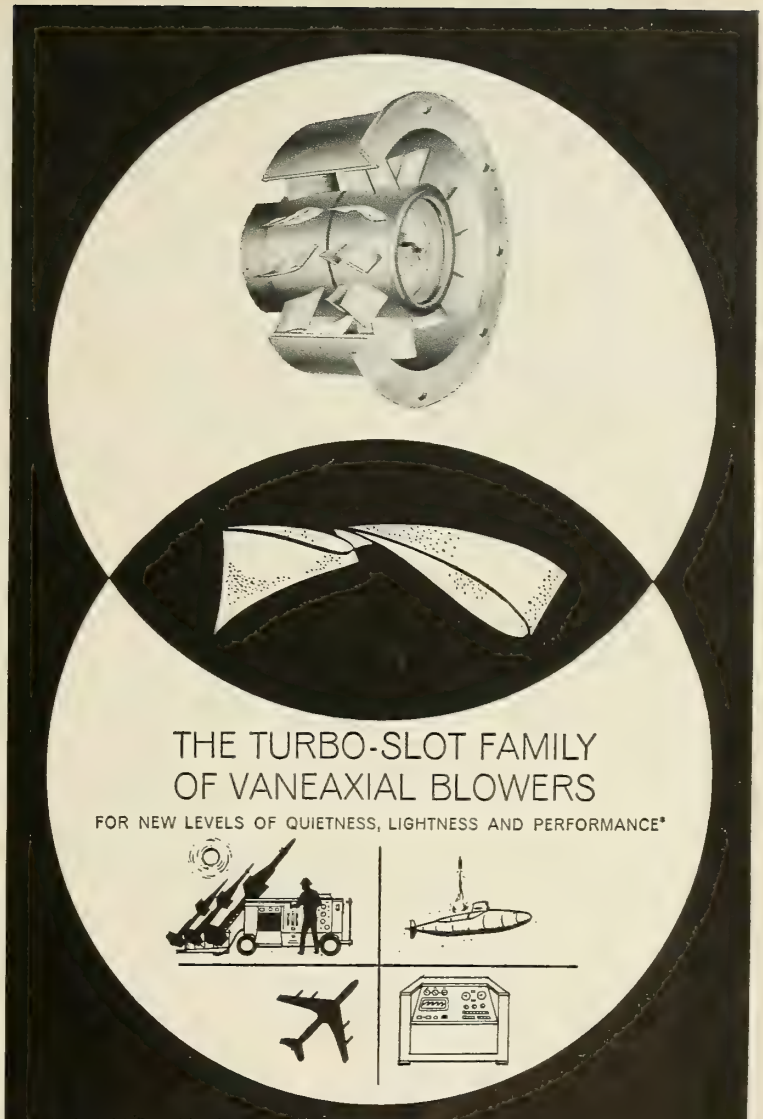
The IAS was accorded non-voting status because Federation by-laws limit the number of voting members to one per country. The American Rocket Society, an early IAF member, is the voting U.S. organization.

## Douglas Fires S-IV Engines

The six clustered RL-10A3 engines for the *S-IV* stage of the *Saturn C-1* were successfully fired for 60 seconds Sept. 24. The firing took place at the Douglas Missile and Space Systems test installation near Sacramento, Calif.

### Space Electronics

With this issue, MISSILES AND ROCKETS introduces a new monthly feature to devote attention to the increasingly important field of new space electronics products. The special section will appear hereafter in the first issue of each month. It will provide industry engineers with eight pages of concentrated, up-to-date information on product designs available from firms throughout the nation. The section begins on p. 34.


Increasingly, Electric Boat Turbo-Slot Vaneaxial Blowers are providing a lighter, quieter, more compact source of cooling for missiles, aircraft, ground support equipment and electronic systems. A wide selection of custom and standard units are now available, operating on DC or 60- and 400-cycle AC power. For details, write or call General Dynamics/Electric Boat, Blower Department, Groton, Connecticut, Hilltop 5-4321, Ext. 1933 or 1106.

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# NASA

## *november 26* MISSILES & ROCKETS SECOND ANNUAL NASA ISSUE

*During the months following November, the National Aeronautics and Space Administration will make final procurement and development decisions on many major programs: Aeros/Advanced Relay/Nova Super Booster/Advanced Syncom/Lunar Logistics Supply Vehicle/Lunar Exploration Module for the Apollo Spacecraft. Each program means millions of dollars to be spent in the missile/space industry.*

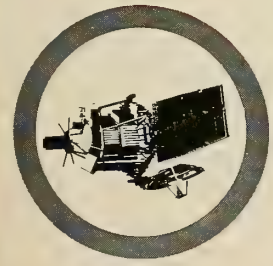
*M/R's editorial task force will visit NASA headquarters and each field center to gather in-depth information on the space agency's present and future programs/budget breakdowns and projections/future contracting procedures/development and launch schedules/new technical requirements/prime and sub-contracting opportunities.*

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# Gemini Spending May Top $700 Million

## *Air Force wants to use capsule as MODS ferry vehicle; NASA considers possible circumlunar mission*

NEW NASA and Air Force plans are likely to push total cost of the *Gemini* spaceflight program well above the current estimated $700 million.

The Air Force, it was disclosed last week, wants to use the two-man spacecraft as the "ferry vehicle" for its *Manned Orbital Development Station (MODS).*

NASA officials reported the space agency is studying use of *Gemini* for a possible circumlunar mission.

DOD officials disclosed that the *Gemini* ferry concept is part of the *MODS* program being considered by Secretary of Defense Robert McNamara.

The two-man vehicle was selected by the Air Force because of its rendezvous capability and its early 1965 availability. The spacecraft would be used to shuttle men and supplies to the 20,000-lb. station, which would have an orbiting lifetime of several months.

Fiscal '64 budget requests for *MODS* call for feasibility studies and program definition competition. The AF is pushing hard for the program and its chances of getting DOD approval appear good.

The AF priority for a rendezvous capability was emphasized recently by Systems Command Chief Gen. Bernard A. Schriever at the Air Force Assn. convention.

He told a panel discussion that while orbital assembly techniques were important to the space effort, he "wouldn't give them top priority, particularly in relation to rendezvous and docking."

Space agency officials refused to make a prediction as to whether a manned *Gemini* circumlunar mission would be approved. They said, however, that quite a few people within the space agency favor the idea. One big problem would be getting the boost power necessary for the long flight.

• **Deep space role**—*Gemini* potential for deep space missions was noted in a recent Manned Spacecraft Center announcement that outlined plans for the program, including a jump in its total cost from $500 to $700 million.

That cost, MSC declared, covers the entire operation, all *Titan II* and *Atlas-Agena D* boosters, spacecraft, support equipment, pre-launch operations and checkout, flight monitoring, data reduction, and ground training equipment.

In Fiscal '63, about $250 million has been allocated to the program by NASA.

A total of 13 spacecraft will be built by its prime contractor, McDonnell Aircraft Corp. Twelve will be flight models and one will be placed in a test chamber for ground systems tests.

MSC says the first mission will be unmanned, the second calls for 18 orbits, and the third will be a two-week trip. The first rendezvous attempt with the *Agena D* will be made on the fifth flight. Length of the *Gemini-Titan II* combination will be 110 ft. The *Titan II* alone is 90 ft. long. The *Agena D* target vehicle is 32 ft. long and 60 in. in diameter.

For the rendezvous mission, the *Agena D* will be launched into an orbit varying from 87 to 150 miles. The *Gemini* spacecraft will be boosted into orbit 24 hours later.

A radar unit aboard the spacecraft will have a range of up to 250 miles. This will be used to lock onto the *Agena* until the two vehicles close to within 20 to 50 miles. At that point, the spacecraft pilot should be able to see a high intensity, flashing light from a beacon aboard the *Agena D.*

Small rocket engines of 25 and 100 lbs. thrust on *Gemini* will be used for final docking.

Other details of the program released by MSC include:

• **Pressure suit** — A new pressure suit development program has been initiated for the *Gemini* program, and study contractors (B. F. Goodrich, Arrowhead Products and Protection, Inc.) are well under way. These suits will have removable arms and legs and a fabric helmet that can be opened and folded aside for astronaut comfort (a "shirt-sleeve" environment) and exercise.

During the *Gemini* mission, the pilots will unlatch their pressure tight hatch, and climb out of the cockpit into space—one at a time—for up to 15 minutes.

• **Adapter Section** — The *Gemini-Titan* adapter section will be carried into orbit with the spacecraft. It will house fuel cells, main oxygen supply, maneuvering control system, retrorockets, etc. The adapter section itself is 90-in. long, 90-in. in diameter at the top (base of the spacecraft) and 120 in. in diameter at the lower end (top of the launch vehicle).

After the *Titan II* has taken the *Gemini* spacecraft to orbital altitude, pyrotechnic devices such as shaped charges that actually cut through the metal, will be used for separating the launch vehicle from the adapter section of the spacecraft.

An array of silver-zinc batteries will be in the spacecraft to provide power—since the adapter section will be jettisoned before re-entry, landing and post-landing phases of the mission. These batteries also serve as an emergency power source during the orbital phase.

• **Paraglider**—To provide solutions to primary landing system problems on *Gemini,* the 63-ft. ringsail parachute used with the *Mercury* spacecraft will be replaced with a "Rogallo Wing" or paraglider, a steerable device with inflatable booms connected with a coated synthetic fabric. The paraglider has a wing-spread of 43 ft. and is 30-ft. long.

Until ready for use in the lower atmosphere, the wing will be carried folded and uninflated in a cannister approximately 10 cu. ft. in size in the cylindrical section of the spacecraft When the spacecraft has completed its entry and has slowed to a subsonic speed at about 60,000 ft., a drogue gun will remove the top of the cannister, and a small drogue chute will be deployed. The collapsed paraglider will be deployed at about 50,000 ft. It will then be released into flight shape, fully inflated, and will be operational at about 42,000 ft. This will permit a landing speed of about 45 knots.

The *Gemini* landing gear will consist of a nose skid and two outrigger skids for stability and support. The nose skid will be extended during paraglider deployment, but the pilot will extend the rear skids. ⌘

***Further delay possible . . .***

# MA-8 Shot To Prep NASA For Two 24-hour Flights

**by Hal Taylor**

NASA's *MA-8* shot will be a dress rehearsal for Project *Mercury's* final two flights in the second and third quarters of 1963. These last two flights of the program are set for 24 hours each.

Cancellation of two interim launches is almost certain.

During the nine-hour flight scheduled this week, space agency officials hope to obtain needed data on drifting-flight fuel and electrical power consumption, tracking and communications procedures and pilot performance.

All such data will help determine the adequacy of spacecraft systems for one-day flights planned before Project *Gemini* flights begin in 1964.

Oct. 3 is the scheduled launch date for *MA-8*, but technical or weather problems could force further delays. Because of the length of the flight, launch must be between 7 and 9 a.m., EDT.

Astronaut Cdr. Walter M. Schirra, Jr., (USN) will be mission pilot. AF Maj. L. Gordon Cooper, Jr., who probably will make the first one day flight, will be backup pilot.

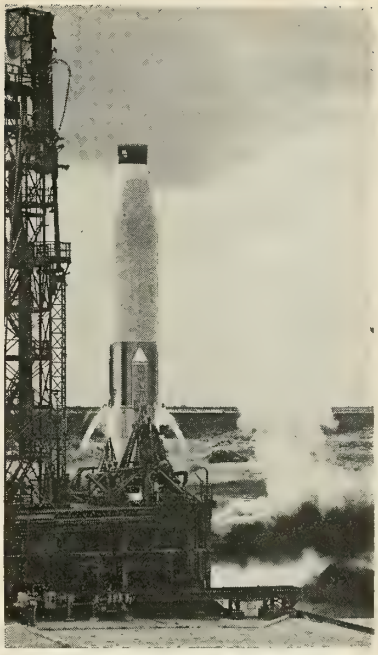
The *Mercury* spacecraft, named *Sigma 7*, will be boosted by an *Atlas D* into a 100-mi. orbit. Spacecraft weight at launch will be 4200 lbs., weight in orbit will be about 3000 lbs. and weight on impact will be 2400 lbs.

• **Recovery areas**—Prime recovery area for a five- or six-orbit mission will be 275 miles northeast of Midway Island in the Pacific Ocean. If the mission is aborted, recovery area for one orbit will be 500 miles east of Bermuda; for two orbits, 450 miles south of Bermuda; for three orbits, 800 miles southeast of Cape Canaveral, and for four orbits, 170 miles due east of Midway.

A very important aspect of the flight is the long period during which the spacecraft will be allowed to drift in orbit. This will allow large savings of hydrogen peroxide fuel in the spacecraft control system and will provide more time for the astronaut's observation and experiments.

• **Scientific experiments** — *MA-8* will also carry four scientific experiments. First of these will be a flare-visibility study. Two sites have been chosen for location of the ground-based flares to decrease the probability of cloud cover interference. At the primary site, Woomera, Australia, three high-intensity flares will be ignited. At the second location, Durban, South Africa, electric lamps of three-million candle power will be displayed.

The second experiment will be photographic studies similar to those conducted on the *MA-6* and *MA-7* missions. A 35mm camera again will be carried. The pilot will photograph such terrestrial features as folded mountains, fault zones, volcanic fields, meteor impacts and glaciers.

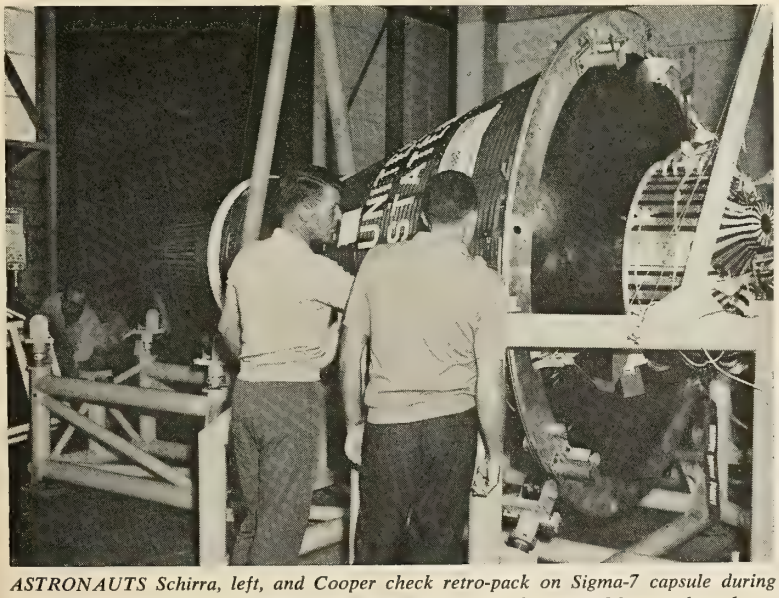


*STATIC TEST firing of Atlas D booster to be used in MA-8 orbital flight.*

The third experiment is a passive one. Certain advanced heat-protection materials, mounted on the cylinderical portion of the spacecraft, will be studied after exposure to orbital re-entry heating. AVCO Corp., NASA Langley Research Center and McDonnell Aircraft Corp. have been assigned two each of the available panels for materials testing. Emerson Electric, Chance-Vought Corp. and General Electric are bonding one sample apiece to each of the remaining shingles.

In addition to evaluation of re-entry heating effects on these materials, discrete cracks or slots will be placed in the materials; half of the "flaws" will be filled or repaired; the remainder will not be altered. This will establish the effectiveness of heat shield repairs and provide non-critical damage as a comparison.

Another *MA-8* experiment is a radiation-sensitive emulsion study sponsored by Goddard Space Flight Center. Goddard scientists are primarily interested in the type and magnitude of nuclear radiation in orbital space. Their experiment has been proposed for study of primary cosmic radiation, gauging the energy spectrum of low-energy cosmic ray particles, measuring high-energy gamma rays, and searching for rare particles. ⌗



*ASTRONAUTS Schirra, left, and Cooper check retro-pack on Sigma-7 capsule during weight and balance tests at Cape Canaveral prior to Oct. 3 Project Mercury launch.*

***For Saturn, Nova tests . . .***

# NASA Announces Mississippi Site Plans

***Construction bids on $500-million facility expected within a year: 1965 completion date envisioned***

NASA HAS ANNOUNCED a three-phase $500-million development plan for its Mississippi Test Facility.

The first phase—with a cost of $200 million—calls for construction of four static test stands, two for the *S-IC* first stage of the *Advanced Saturn* and two for the big booster's second stage.

About 20 support buildings are also included, with completion scheduled for 1965.

No final decision on the scope of the second and third phases of MTF development has been made, the space agency said. It is expected that additional test stands will be needed for the *Nova* launch vehicle and the M-1 and F-1 rocket engines.

It is also probable that the RIFT nuclear upper stage and future big solid boosters, as well as other rocket engines, will be test fired at the site. This is expected to push the final total cost well above NASA's current estimate (M/R, May 21, p. 41).

MTF is under direction of NASA's Marshall Space Flight Center. The test facility is located on a 141,500-acre site in Pearl River and Hancock Counties, Mississippi and St. Tammany Parish, Louisiana. The space agency purchased 13,500 acres and has obtained easement rights on a 128,000 acre buffer zone.

• **Construction bids**—Bids for construction of the four test stands in the first phase will be requested as soon as site preparation and design studies are completed. This could take six to 12 months.

Other highlights of the first phase development plan:

—In addition to test stands, numerous structures such as an engineering lab, acoustical lab, electronics and instrumentation lab, site maintenance building, automotive shop, inflammable materials storage, warehouses, telephone building, emergency services, central control, data handling center, *S-II* storage, *S-IC* storage and fuel storage will be constructed.

The largest structures, with the exception of the test stands, probably will be the rocket stage storage buildings—about 200 ft. by 235 ft., with ceilings about 70 ft. high. They will facilitate minor-stage repair and modification and safe storage of rocket stages in case of hurricanes.

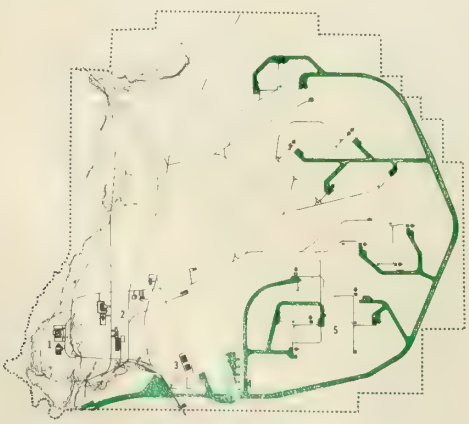
—A barge area and lock will be built at the southwest corner of the test area. The conventional lock, 110 ft. by 600 ft., will provide about 20 ft. of lift from the Pearl River level to the MTF canal system.

—A peripheral canal will be built along the south and east sides of the test area, with branch canals leading inward to booster and engine test stands. Some 15 miles of canals will be constructed and 15 miles of river channel improved. The canals, 15 ft. deep and 200 ft. wide, will permit unloading rocket hardware directly from barges onto test stands. The canal system will also serve as a water reservoir for cooling jet deflector plates and for fire fighting.

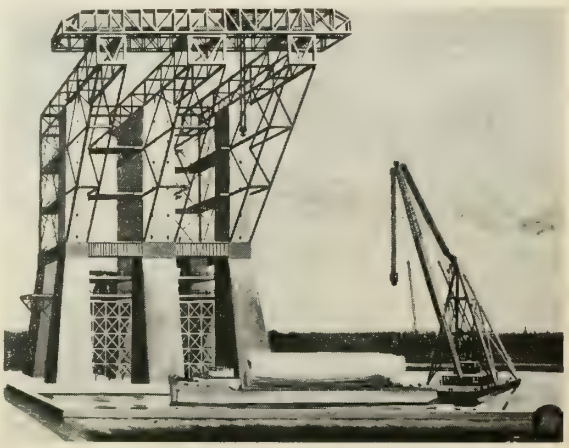
• **Central control**—All operation at MTF, including canal traffic, will be handled from the central control building, which will include a tall, airport-like control tower where personnel will be in touch with all operations by radio and closed circuit television.

A large portion of the test personnel at the facility will be contractor employees to assemble rocket stages required for the manned space flight program. Most of these are under direction of the Marshall Center.

The St. Louis firm of Sverdrup and Parcel is preparing the MTF design criteria. The Army Corps of Engineers, Mobile District, is acquiring the land for NASA, in cooperation with the Lands Division of the Justice Department. The Corps of Engineers also will manage and supervise construction. ⁂



*FIRST PHASE facilities are numbered as follows: 1) engineering and administrative area, 2) industrial area, 3) vehicle and service storage area, 4) barge area, and 5) test stands.*



*ADVANCED SATURN S-IC stage test stand appears in artist's conception. Stages will be unloaded from barges directly onto stands, part of the $500-million MTF site.*

***Research chief cool . . .***

# DOD's Brown Expected To Veto SLAM

***$24 million withheld pending re-evaluation despite Air Force, Navy support for nuclear missile***

**by Charles D. LaFond**

PLUTO, the Air Force program leading to the development of a supersonic low altitude missile system (*SLAM*), may be following the aircraft nuclear propulsion program down the DOD drain. Industry and congressional observers believe its liquidation will result from the same piece-at-a-time technique.

In the face of AF arguments citing many critical advantages inherent in this mode of weapons delivery, despite the fact that this is the only air-breathing nuclear propulsion system now being developed, despite a top Navy officer's claim that it is potentially the best long-range single weapon yet conceived, Dept. of Defense is withholding this year's $24-million appropriation pending program re-evaluation.

Dr. Harold Brown, director of DOD research and engineering, will turn in his recommendations concerning the program to the Secretary of Defense within a month.

Despite his protestations to the contrary, members of the Joint Committee on Atomic Energy at the recent Pluto hearings expressed the belief that Brown's decision most probably would determine the fate of the program.

From the temper and tone of the congressional interrogators, led by Chairman Melvin Price (D-Ill.), it was obvious that they believed his thumbs-down decision had already been made.

• **AEC awaits decision**—Based on the Tory IIA-1 successes, General A. R. Luedecke, AEC general manager, stated that the AEC considered technical feasibility of a nuclear ramjet reactor to have been generally demonstrated.

Tory IIC testing by Lawrence Radiation Laboratory (LRL), in Nevada, is scheduled for next summer. In response to a Navy request, the Lab also is studying nuclear ramjet systems for naval applications.

Noting LRL reports of reactor successes, the committee expressed concern over the lack of a DOD decision to press forward Pluto R&D toward a flight test. Also, the committee questioned DOD's reticence in establishing a single responsible program manager.

Apparently, the Air Force and the AEC have been able to work together effectively in the past with respect to Tory IIA and IIC development and testing. However, Gen. Luedecke indicated that Air Force guidance would be required before AEC could select a contractor for any follow-on program.

Dr. Theodore Merkle, LRL associate director, agreed and stated that only by selection of a reactor contractor now could it be expected that flight testing would be possible by late 1964 or early 1965. Actually, $5 million has been available from AEC for such contractor funding since July 1. AEC, however, could not make any award without being furnished the scope of work required by the AF.

• **AF approach cautious**—The Air Force position on *SLAM* is cautious. While it feels a need for continuing the propulsion development effort for possible use in a low-altitude long-range weapon system, it does not now have a firm requirement for such a vehicle.

A proposal has been submitted to DOD to continue the program to the extent that both the engine and vehicle technology would be advanced sufficiently to provide a clear option for proceeding to an operational system if required, according to AF Secretary Eugene M. Zuckert's testimony.

Under repeated questioning concerning the lowering of Pluto from priority Category II to III last year, Zuckert stoutly defended the decision. It is based on the definition of Category III projects, he said, because lack of this system would "not create a critical degradation of our military capability."

Reactor development is considerably out of phase with engine R&D, being ahead by from 1 to 1½ years. The newly proposed coordinated program now awaiting DOD approval is designed to adjust this development deficiency, Zuckert claimed.

The committee then asked what would happen if DOD continued to withhold the $24 million authorized by Congress for Pluto/*SLAM* R&D. "No money, no program," said Zuckert. He then stated that if DOD decided next year to re-establish the program it would cost an additional $1 million with the present contractors or $10 million and two years delay with new contractors.

Gen. Bernard A. Schriever, AFSC commander, firmly seconded Zuckert's remarks. Elaborating on the AF proposal for project continuation, he said it sets forth a "logical three-step approach to propulsion feasibility demonstration." In summary, these included (1) a basic engine ground test program to provide a first, though rudimentary, thrust device, (2) a flight-rated engine ground test program, and (3) a flight test program for the latter engine.

Then, said Schriever, "We must not lose sight of the uniqueness of a nuclear ramjet capability because of the numerous and critical advantages that may accrue in terms of additional flexibility of weapons delivery. There is no currently known method of achieving supersonic speeds and unlimited range through the atmosphere, particularly at low-level, other than through the application of nuclear power."

Also, he added, no other air-breathing nuclear propulsion system is under development.

Supporting this argument, John S. McCollom, Pluto program manager for the AF, told the committee: 60% of the results so far obtained from the AEC-AF effort apply to other atmospheric systems, gains associated with the radiation environment would be useful in space programs, and possibly 85% of the technical advances would be useful elsewhere.

• **Navy agrees with AF**—The Navy, which has followed the Pluto program from its inception and has funded studies for the past three years, supports the Air Force position unequivocally, testified Vice Adm. W. F. Raborn, Jr., deputy chief of Naval Operations for development.

Praising developmental efforts of both the AEC and AF, Raborn asserted that Pluto could complement a *Polaris*-type missile system of the future and could be applied in both surface and undersea naval craft. The combination of the *Polaris* weapon system with a

nuclear ramjet engine might be potentially the most powerful single weapon yet conceived, he said.

• **Brown dampens enthusiasm** — DOD interest in Pluto and *SLAM*, said Fred A. Payne, deputy director of Defense Research and Engineering, lies in the possibility that some future enemy A-ICBM systems might degrade the effectiveness of present ballistic missiles.

But he cited three other possible ways to effect low altitude penetration: maneuverable ballistic re-entry vehicles, sea- or air-launched chemically propelled short-range low-altitude cruise missiles, or an advanced manned aircraft system with low-altitude penetration capability. The latter is not the RS-70, Payne said in response to intensive committee questioning.

(Subsequent testimony by Dr. Brown indicated that all three alternatives were but concepts now.)

Payne indicated that reactor feasibility will be established by the end of the Tory IIC test series. He foresaw no serious propulsion system development problems. However, he said flight testing would be very expensive, complex, and might generate international political problems similar to those resulting from nuclear weapons testing.

The committee again expressed concern that DOD, despite AF/Navy endorsement, was going to kill the program. Almost every question posed by committee members to Payne was fielded by Dr. Brown.

Upon learning that DOD might withhold the $24 million authorized for AF, Rep. Craig Hosmer (R-Calif.) asked if this represented another step in an effort to kill the program in stages.

• **Brown parries**—In the fencing that followed, Brown said: "Not all programs which are technically feasible should be carried through. As part of our regular review we have to balance all our programs against each other before committing ourselves in one direction. Turning to Pluto in particular, we are now looking at engine development and non-engine development with the Air Force."

Asked why DOD chose this time to re-evaluate the program, Brown said, "sometimes a given approach, although it is better than another approach at the moment, is still not the approach which will finally be decided upon."

The high cost of R&D for Pluto might be an important factor in any DOD decision concerning the program. Brown stated that the least that will be done is to carry through the planned Tory IIC tests. This would cost more than $20 million. Ground testing the reactor with the ramjet engine would cost another $100 million, pre-flight engineering, $100 million and flight testing an additional $300 million.

Going back to Payne's testimony concerning alternative penetration methods, the committee asked what else was being done in this field by DOD. Several million dollars have been allocated, said Brown, to fund studies for maneuverable vehicles competitive with *SLAM*—but not necessarily better.

The whole program is being reconsidered now, Brown claimed, because contractor funding is on a calendar year basis, rather than fiscal. But, said a committee member, "these funds were considered minimum when first requested. How do you justify program elimination?"

"All programs," said Brown, "are balanced against each other" during periodic reviews. ⠿

## SLAM To Cost $500 million Through Flight Tests

An estimated $500 million will be required to carry Pluto/*SLAM* development through flight testing. The project's history follows.

The Department of Defense in late 1955 requested the Atomic Energy Commission to take part in feasibility studies of a nuclear ramjet engine and Project Pluto was initiated in 1956. In 1958, Pluto was reoriented toward a low altitude supersonic missile, after two years of concentrating on materials R&D.

Three firms were awarded $200,000 study contracts by the Air Force in FY '59 to determine feasibility of a supersonic low altitude missile *(SLAM)* using a nuclear ramjet engine: Chance-Vought, North American Aviation and Convair.

*SLAM* capability was to include at least a 12,000-mile operating range, Mach 3 speed, and have a variable-range flexible target-seeking capability.

The C-V proposal was selected as best and the company continued to develop, with its own funds, a detailed study of development problems.

Theoretical reactor studies by AEC has shown technical feasibility. But to obtain real propulsion engineering feasibility, it was decided to build and test a series of reactors (Tory). The first, Tory IIA-1 and its backup Tory IIA-2 were to be used to checkout reactor core materials and to permit study of aerothermodynamic behavior of the core-air heat exchange system under simulated low altitude supersonic flight conditions.

**Pluto/SLAM Status Report**

Actual and Planned Expenditures (millions)

| Agency | Funding FY '55-62 | Planned FY '63 | Total |
|---|---|---|---|
| AEC | $102.5 | $29.0 | $131.5 |
| Air Force | 30.8 | 24.0 | 54.8 |
| Navy | 0.2 | 0.3 | 0.5 |
| TOTAL | $133.5 | $53.3 | $186.8 |

In the meantime, the *SLAM* program was oriented toward subsystem development. Chance-Vought was selected to perform developmental work in airframe structural studies, radiation and thermal studies associated with guidance and control, plus over-all system studies. Ramjet design work was undertaken by the Marquardt Co.

Tory IIA-1 was developed and tested by the AEC's Lawrence Radiation Laboratory in May 1961, at reduced power (50 Mw). This test was followed by three full-power (150 Mw) ground tests ending in October 1961. So successful were the tests that Tory IIA-2 was eliminated from the test program and work moved directly to Tory IIC—the step between the earlier engineering feasibility reactor and a flyable prototype.

The Navy in 1961 began funding a study effort to determine feasibility of employing nuclear ramjet missile systems on both submarines and surface vessels. It also initiated a penetration-aid study project.

Tory IIC is now in final development, awaiting completion of new test facilities at the AEC's Nevada Test Site. Tests will begin next summer.

The Air Force wants to extend its R&D program into propulsion system airframe integration, radiation effects on flight vehicle electronics (breadboards only) and further development of structural criteria associated with high-speed low-level flight. Finally, it wants to extend its materials research, breadboard all necessary subsystems, and carry out stress and vibration analyses.

The Air Force requested $40 million for its program for FY '63; it was authorized $24 million by Congress, and the funds are now being held by DOD. If the program survives DOD review, AF is expected to request another $30 million for FY '64.

# Technical Countdown

## PROPULSION

### Soviets Plan Ion Engine Flights

Electrical propulsion systems investigations conducted by the Russians are centering on ion engines. Laboratory tests have been made and "many of the problems connected with assembly of these on rockets have been solved" says a Czech author. Plagued with the same problems as their U.S. counterparts, the Russians recognize the power supply obstacle but claim the engines will be used for planetary probes in the next three to four years.

### Cap Pistol Controls Under Contract

Curtiss-Wright is assembling prototype models of its "cap pistol" attitude control system under contract to the Air Force's 6953d Test Group (Dev.), Edwards AFB. The encapsulated solid-propellant pulse engine is capable of extremely small, highly controlled pulses in varying increments. Tiny bits of solid propellant are embedded in plastic tape, each with its own self-contained, shaped nozzle. These miniature engines can be fired individually or rapid-fire, as determined by a direct-action digital computer. The firm is investigating feasibility of a variable-position mounting to eliminate need for several units on a given spacecraft. The concept could also be applied to gimballing huge rocket engines, eliminating currently used hydraulic plumbing.

### Hybrid Rocket Flown

Engineers at the Naval Ordnance Test Station, China Lake, Calif. have successfully free-flight tested a hybrid propulsion system using a combination liquid and solid propellant in a single motor. The motor is an outgrowth of the station's propellant and propulsion research and development programs sponsored by the *Polaris* Special Projects Office.

## ADVANCED MATERIALS

### Russians Gear Up for Quiet Solar Period

Additional *Cosmos* satellites will be launched by Russia towards the end of 1962 to gather information related to long-term space flight with particular emphasis on preparation for lunar activities during the "quiet" solar period due to begin in about three years. Soviet space probes will test new materials, particularly laminates with silicon fibers—suitable for nose cones and other re-entry vehicles. Ceramic-metal alloys such as 72% chrome and 28% aluminum oxide will be tested, together with zirconium carbide, silicone carbide and zirconium boride.

### Carbon-Silica Laminates Tested for Nozzles

Two 42-in. diameter tape-wound carbon-silica composites fabricated by U.S. Polymeric Chemicals Inc. are undergoing tests to determine feasibility of replacing currently used graphite and carbon cloth inserts. Sections were made from the firm's Poly-Preg FM 5063 carbon tape using a highly substituted ring-structure, phenyl aldehyde condensation resin system, tension-wrapped over a mandrel and de-bulked in a vacuum bag. The carbon tape was overwrapped with Poly-Preg XA-0-34-2 high-silica tape using a modified MIL-R-9299 phenolic resin. One section was completely cured at once in an autoclave and the other involved curing first the carbon wrap and then the silica overwrap.

### Diphenyl Oxide Attacks Silicone Resin Market

Westinghouse Electric Corp. will make a major attempt to displace silicone resin insulators for many high-temperature Class H requirements with newly developed diphenyl oxide thermosetting resins. Available as a varnish, pre-preg and pre-preg coating, "Doryl" allows full retention of mechanical and electrical strength, resists solvent attack, causes no brush wear and costs less than previous Class H materials. The resins also have applications as binders in filament winding. Bond strengths have been maintained over 3000 hours at 250°C.

### Sprayable Material Resists Radiation

A family of materials combining thermal and radiation-resistant properties based on boron and lead compounds dispersed in various epoxy, polyurethane and silicone binders is being prepared for commercial production by Dyna-Therm Chemical Corp. The mixtures are equivalent to lead on a mass-per-unit area basis against high energy gamma radiation. The materials can be cast, molded, poured, sprayed or brushed to provide thin, effective coatings.

## ASTRONAUTICS

### PMR Checks Impact Location System

The Pacific Missile Range has completed checkout of a missile impact location system (MILS) destined for a major role in pin-pointing the *Sigma-7* capsule impact area. A small "bomb" will be released from the capsule at parachute deployment. Underwater detonation of this charge will be received by MILS stations at Kaneohe, Midway, Wake and Eniwetok, fixing the direction of the sound source. Data from each station will be transmitted to computers at Kaneohe, Hawaii, and a general fix then provided to NASA and Navy recovery vessels. MILS data also will be received at PMR headquarters, Point Mugu, for back-up support.

### Radiation Dosage Device Perfected

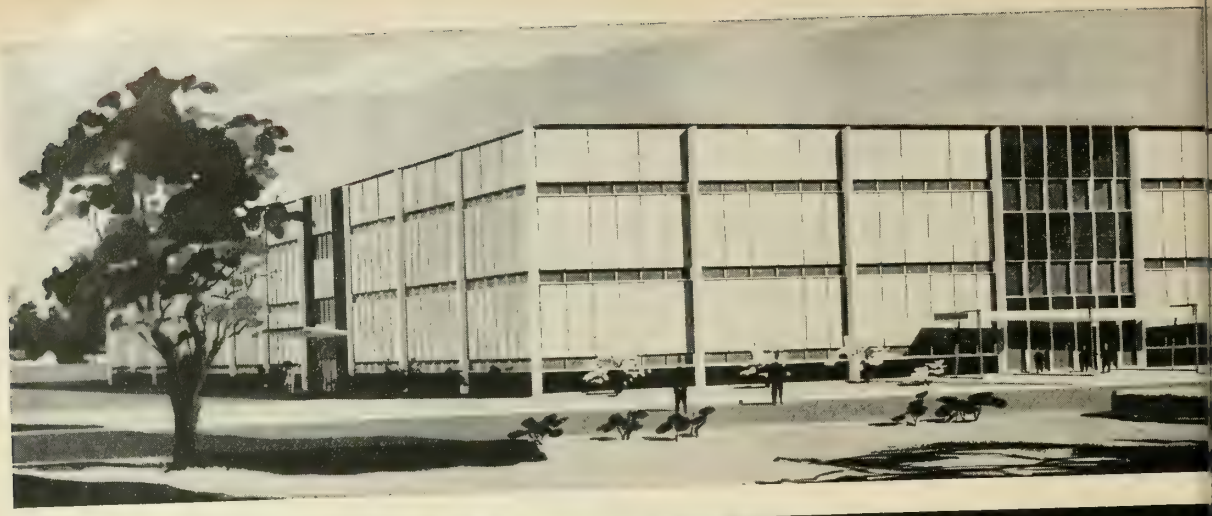
Direct measurements of the radiation absorbed at five points on an astronaut is possible with a set of tissue-equivalent ionization chambers developed under Air Force funding by Hughes Aircraft Co. The system is completely transistorized except for the electrometer tubes and weighs only 20 lbs. Automatic calibration is provided every two minutes during its 150-hour or greater lifetime. Trapped radiation in the chambers creates a minute electric current which is then amplified by the individual chamber for transmission to other portions of the system where further amplification produces a signal suitable for telemetering.

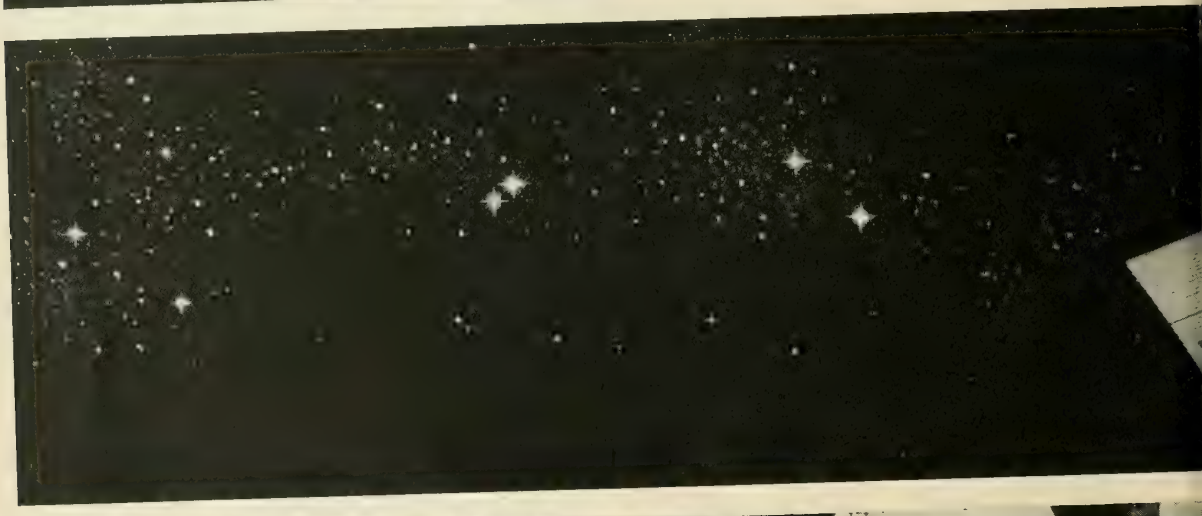
### SNAP 8 Reactor Run

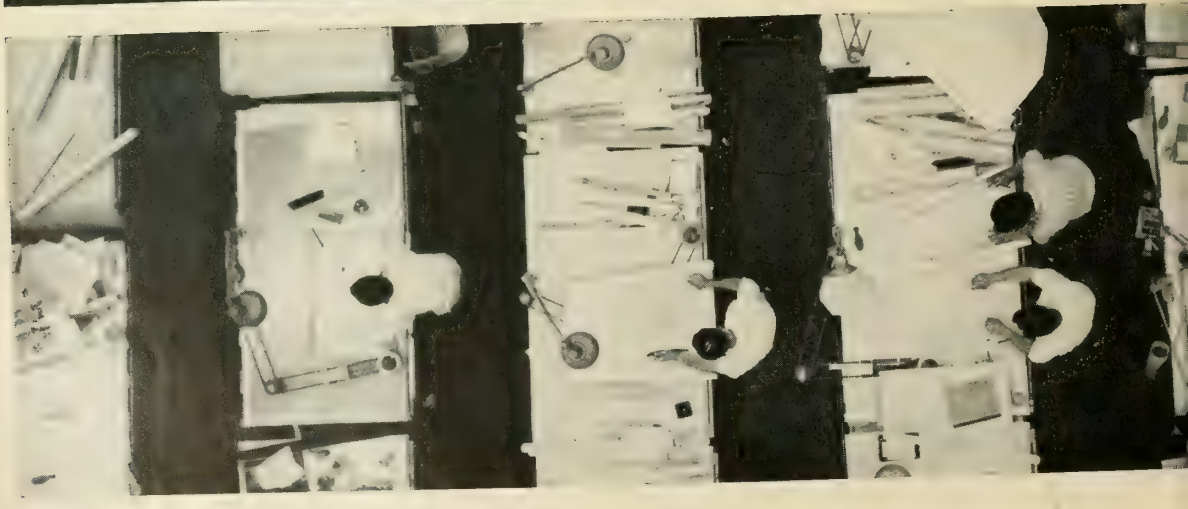
First nuclear reactor in the SNAP 8 program has been operated by Atomics International at the AEC Santa Susana, Calif., facility. The reactor was operated at very low power without the electrical generating system. Full power run is not expected before next year.

### Lightweight GSE Reactor Tested

World's smallest portable nuclear reactor was hooked up to a power-conversion unit late last month and successfully produced electricity. Developed by Aerojet-General Nucleonics for the Army nuclear power program, but having wide uses in the missile and space GSE field, the 40-ton nuclear powerplant—ML-1—is designed to run at full power—300-500 kw—for a year without refueling.



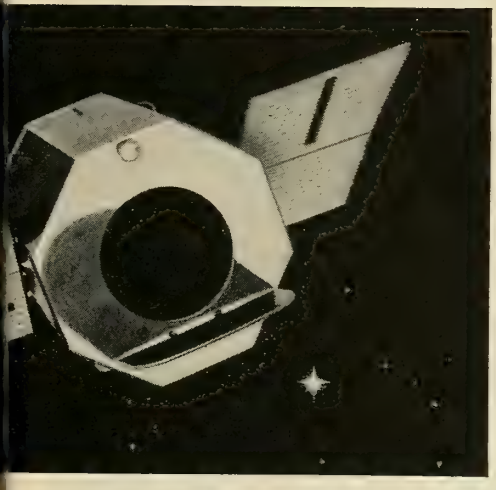






# FACILITIES

Latest step in Grumman's long-range aerospace programming is construction of a new $5 million Space Engineering Center, shown here in an architect's drawing. Along with the recently completed Electronics Systems Center and in-progress Research Center, this new complex of aerospace facilities will give Grumman the physical capabilities and resources to undertake major space system assignments.



# EXPERIENCE

In the early 1950's, Grumman instituted a comprehensive, long-range program of space studies. Significant areas were hypersonics, reentry, capsule retrieval, orbital transfer and lunar vehicles. Major accomplishment to date is acquisition of the OAO (Orbiting Astronomical Observatory) contract and the Echo II canister assembly. More recent study contracts include the performance study for Lunar Logistics Systems and a new contract study in Lunar Astrodynamics. Against the background of 33 years' experience in solving the man-machine equation in aircraft and weapons systems, Grumman now offers a fully integrated space capability.



**AND ESPECIALLY**

# PEOPLE

Grumman's most valuable asset is people: scientists, engineers, technicians and craftsmen. This work force provides an unbroken network of interlacing aerospace experience and skills. Over all is a management team with the uncommon knack of fitting man and machine together . . . of correlating large-scale programs simultaneously . . . of ensuring "total company" effort . . . of transforming advanced ideas into reality.The Grumman work force is by far the most stable in the industry.

# GRUMMAN

**AIRCRAFT ENGINEERING CORPORATION**

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# New Test for Glass Filament Windings

***Goodyear develops non-destructive method that monitors motor case condition during production or after delivery***

**by John F. Judge**

AKRON, OHIO—Engineers at Goodyear Aircraft Corp. may soon be able to determine non-destructively the structural integrity of a glass-filament-wound solid or liquid-propellant chamber regardless of its disposition—during production, after delivery, aboard submarines or on the launching pad.

The method may also provide new insight into failure mechanisms before, during and after actual physical breakdown.

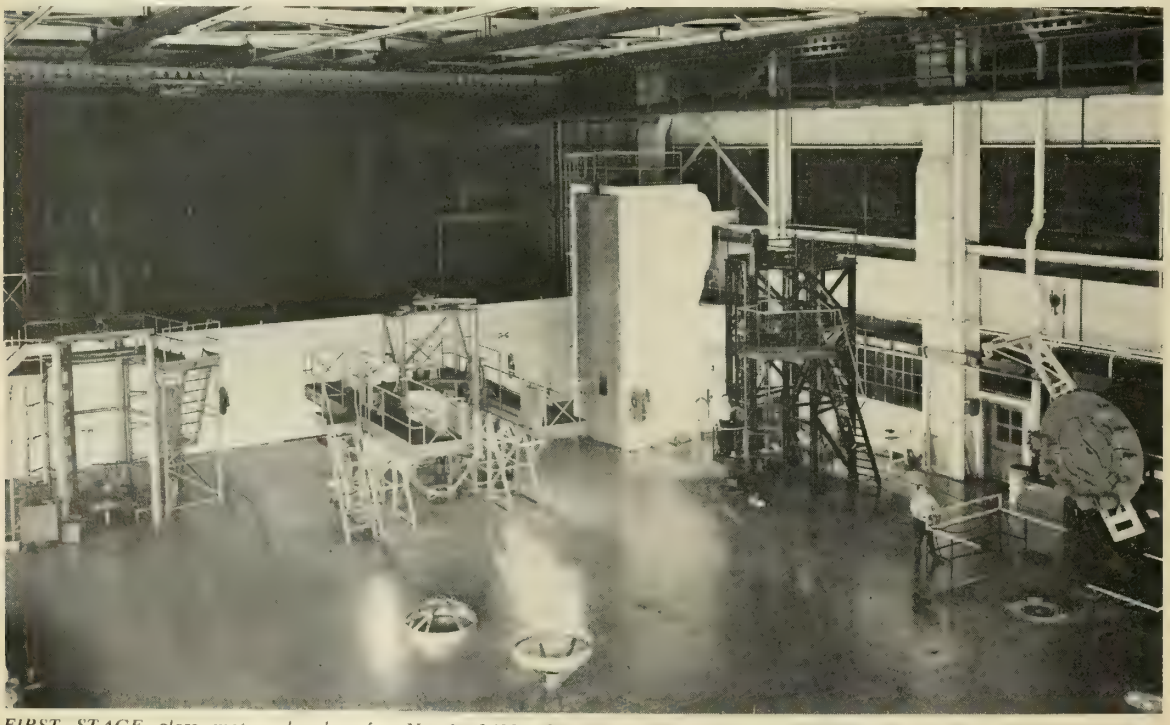
It could generate definite data on the condition of a motor case after hydrotesting and perhaps even eliminate the expensive burst tests currently used to check production lots of solid motor cases.

The technique consists of winding an electrically conductive trace element into the structure during the fabrication process. GAC uses a light coat of aluminum on a statistically chosen number of ends in the rovings. Test bottle experiments have shown an increase in resistance after each cycle in hydrostatic runs—probably due to individual filament breakage in the roving. The aluminum coatings have not proven detrimental to the filament-wound structure.

The technique is still in the experimental stage but experts see no technical problems in adapting it to existing winding operations.

• **Glass for liquids**—GAC is also developing flexible filament-wound structures with an eye toward propellant tanks in large liquid rockets such as *Nova*. Currently in research and development, the flexible approach solves the transportation problem associated with these massive units. A flexible or packageable *Nova*-scale tank can be carried by railroad flatcar to the vehicle assembly location.

The firm has built small 10-in. bottles and checked out a host of possible reinforcing materials such as metals, synthetics (Dacron, nylon, etc.) and glass. The key flexibility is in the binder choice. This, together with winding techniques, has resulted in a Dacron



*FIRST STAGE glass motor chamber for Navy's 2400-mile Polaris A-3 will be fabricated on this production line at Goodyear Aircraft. Right to left: in-place vertical winding machine capable of handling parts up to 6 ft. in diameter and 18 ft. long; vertical circumferential winding machine; vertical forced-air oven instrumented for programed operation and capable of rotating cases during cure; mandrel-removal fixture. Far left is a vertical checkout stand for dimensional and other measurements.*

composite of unusual strength-to-weight levels.

Flexible filament structures involve a translation of technology from current chambers, such as *Polaris,* with a change in material. Winding patterns and other aspects remain essentially the same.

The prime benefit is packageability, but other applications can be foreseen—such as expulsion systems for zero-g operation. GAC sees no great difficulty in winding integrated fuel/oxidizer tanks. Structural rigidity would be accomplished through pressurization.

Filament-winding devices are essentially machine lathes supporting the shape to be wound. The lathe carriage contains the resin-impregnating equipment and guides for directing filaments to a programed shape.

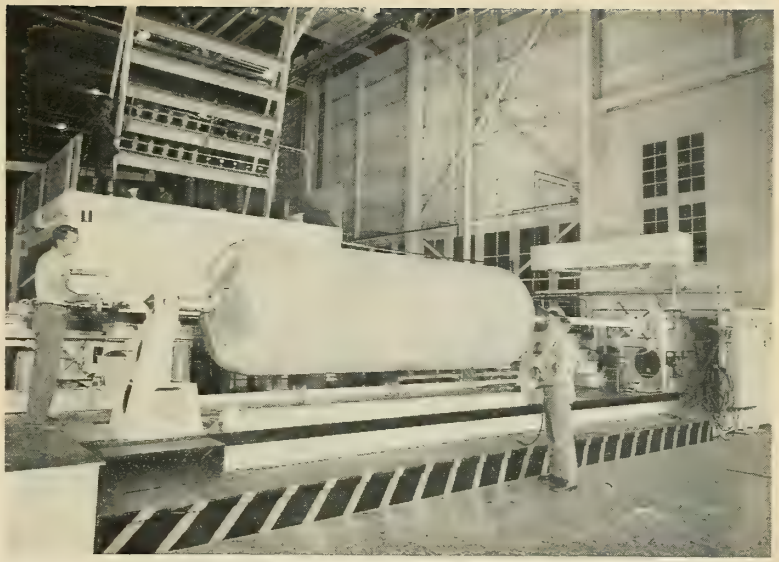
Simplified, the filament-winding technique consists of passing a number of glass filaments or rovings through a resin bath, and winding the resin-coated filaments on a surface of revolution under a programed tension. The filaments emerging from the resin bath are adjacent and parallel to each other, forming a web. The mandrel (surface of revolution) supplies the outline and is removed after curing operations.

The tension imparted to the resin-wetted webs during winding squeezes out excess resin, providing necessary curing pressure. After winding, the structure, mandrel and axle assembly are placed in an oven and cured from 3 to 46 hours at 100° to 500°F.

• **Variable patterns**—Spool or circumferential wrapping is a technique in which filaments are wound essentially perpendicular to the mandrel axis. Helical wrapping puts more of an angle on the filaments with the same axis base, and in-plane wrapping involves winding filaments on the mandrel in great circles. Several of these techniques normally are applied to a specific configuration. The number, type and amount are determined by design configurations.

An accurately controlled resin-to-glass ratio is the most critical variable in winding. It involves resin pick-up, bath viscosity, winding tension, pattern, degree of B-staging before cure and the rate of heat transfer during cure. Key to holding precise tolerances in the finished product lies in successful control of each of these variables.

Impervious liners can offset the inherently porous nature of glass-wound structures, and large tanks could be wound on a mandrel with the liner and insulation layers already in place, as is the current practice. GAC experts say the larger the part, the more economical is the operation. The firm can draw on the vast potential of its parent organization—Goodyear Tire & Rubber—for elastomers and other liners (see box).



*THIS LARGE numerically controlled winding machine is used both for pilot or initial production and research pressure chambers. The unit can be easily expanded.*

GAC is no newcomer to the filament-winding field, having started with pressure vessels for the Allegany Ballistics Lab in 1949. The firm now holds a contract for *Polaris A-3* first-stage motor chambers from Aerojet-General Corp.

A wide range of research programs backs up this production facility including a large, numerically controlled winding machine for research. Production machines capable of fabricating closed-end pressure vessels as large as 97 in. across and 312 in. long are available.

This can be expanded to 240-in. by 540-in. and larger. The winding capability of these machines ranges from low-angle in-plane and circumferential wraps to the more complex helical patterns.

These machines have produced a variety of developmental and production configurations involving axial wrapping requirements varying from low-angle in-plane to multiple circuit helical-wrap windings.

Indicative of the firm's versatility is a small research project involving a filament-wound tire for a lunar vehicle. A 9-in. diameter tire, 4-in. wide with a 4-in. center opening and weighing less than 16 grams has been wound to meet a one lunar pound load requirement. But the tire buckled under the specified load because of the fiber employed.

Proper fiber pantographing was a problem, until the researchers developed a satisfactory flexible binder. The firm is certain a 1-oz. weight level can be met.

While still working on this problem, GAC found the tire almost perfect for another application—the elbow of an experimental NASA space suit.

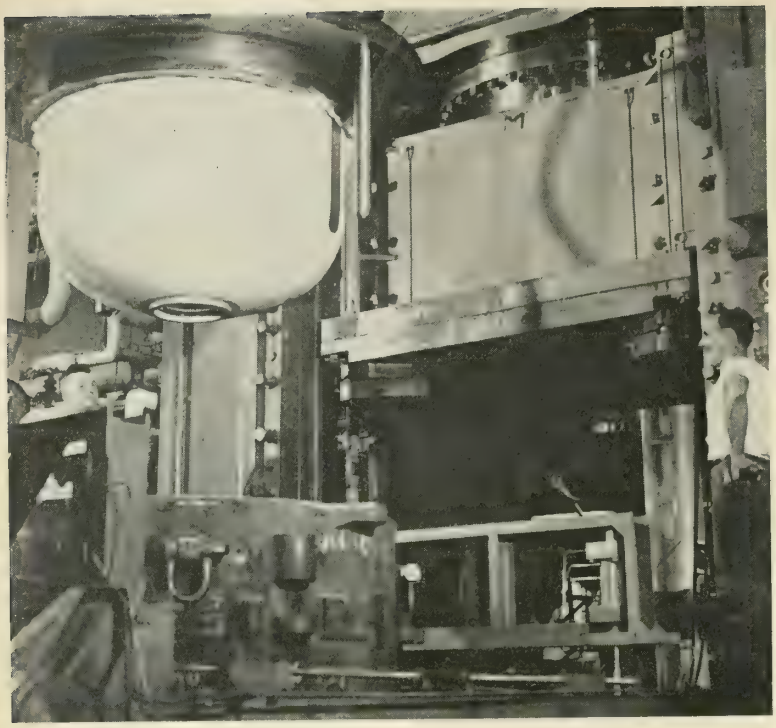
• **Pressure bottle work**—High pressure bottles represents another area of effort. GAC designers can meet any mission or end-application requirement in terms of strengths and weights—and often exceed the specified contained volume within the on-board space limitations. But as long as the spherical shape remains mandatory, glass cannot compete realistically with metals.

By optimizing the shape, glass winders could be freed from the round bottle configuration requirement. The design could be optimized to fit the application, using the maximum potential of filament winding.

Fabrication of head contours has never been a problem at GAC. The firm has had a unique capability in stress analysis since the early airship days. When filament winding came along, the experience fit perfectly. They now have an analytical system of parametric pro-



*ONE OF MANY flexible bottles wound by GAC is this Dacron-reinforced polyurethane vessel shown partially collapsed.*



*A 13-TON mold core is removed from Goodyear press, together with a cured solid-rocket insulating liner segment. Integral liner now moves to X-ray inspection area.*

## Big Press Completes Goodyear Facility

A multi-million dollar solid rocket insulation liner production facility reached completion recently with installation of a huge, two-story curing press at Goodyear Tire & Rubber Co.'s Aviation Products Div., Akron, Ohio.

The division turns out insulation for both *Minuteman* and *Polaris* missiles; the new press eliminates the tedious hand-layup methods of aft and forward dome insulation.

The matched-die mold technique made possible by the press permits closer dimensional and density control, more precise reproducibility and uniformity and greater flexibility in complex designs.

The press — delivered and installed by Verson Allsteel Press Co. within 20 weeks of the Goodyear order—has been working around the clock on the missile liner program.

Capable of handling 10 million lbs. of pressure from a few minutes to 25 hours or longer, the press controls temperatures to within a few degrees. Dimension tolerances can be held to within 0.005 in., electronically programed. The unit has a 6-ft. stroke, 8 ft. of daylight and a platen 96-in. square. A 35-ton overhead crane services the press.

After molded liners are cooled and cured, they are routed to an X-ray room where as many as 120 shots are taken with a 150-KVA unit, checking for bubbles, blisters or cracks.

Then the firm's quality control staff spends hundreds of hours checking dimensions and pressure capabilities of each insulator, its thrust terminators and nozzle parts.

The liners are shipped either to the prime contractors or to the nearby Goodyear Aircraft Corp. for filament winding. All are destined for glass fiber-wrapped cases. They are fabricated of synthetic rubber. Goodyear considers the field highly competitive and will not disclose the nature of the rubber or the curing and forming cycles involved.

E. M. Eickman, general manager of the division, says the press and accompanying production line puts Goodyear in the front rank of missile liner suppliers. The firm now has the ability to turn out interchangeable segments of insulation material without having to farm out any phase.

cedures to optimize head contours in relation to the wrapping angles.

GAC uses a metal-segmented, barrel-type base mandrel with a water-soluble matrix. This system lessens the possibility of case damage during mandrel removal and results in reduced mandrel gross weight.

Larger mandrels for the proposed flexible tanks could be inflatable or trussed aluminum and foam. In any case, GAC specialists anticipate less of a problem with huge mandrels than were faced with present sizes.

• **Research backup** — There is a constant, company-sponsored program in materials research, evaluation and design. The performance of the various glasses used are known, both from in-house studies and information from the materials supplier.

One small facet of this effort involved a study into the characteristics of small test vessels fabricated from the new X-994 (HTS) glass roving developed by Owens-Corning Fiberglas Corp. under Air Force funding. Goodyear found the X-994 glass superior in ultimate tensile strength to ECG HTS (EPS-4) glass roving, and feels the new glass will eventually move into production programs. Investigation into this and other glass formulations continues.

Besides glass filaments, the firm is also studying nylon, orlon, rayon, Dacron, metals, ceramic, refrasil, quartz and refractories—alone and in combinations. Experience in resin systems includes polyesters, epoxies, phenolics, phenyl silane and silicone.

All this effort is combined with intensive winding control procedures. GAC equipment capabilities include:

—Filament placement and indexing control based on 421,575 computer-calculated pattern and indexing ratios with accuracies up to seven decimal places.

—Maintaining simultaneous tension control of 60 spools within an ounce-fraction per spool regardless of lineal speeds.

—Shape possibilities covering cylinders, ogive and tapered cones, or ellipsoidal configurations.

—Guaranteed (absolute) pattern repeatability for in-plane, helical and circumferential winding patterns, with 0 to 90° wrap-angle control in each.

Experience has led GAC to develop both theoretical and experimental analysis for filament-wound structures—permitting application of optimized winding patterns to a variety of shapes. Besides the previously mentioned head contours, this analysis covers orientation of filaments for attachment purposes and secondary reinforcement requirements for nozzle and termination port openings integrated within a given structure. ⁂




*MOCKUP OF Air Force's X-20 (Dyna-Soar) unveiled at Air Force Assn. meeting.*

space systems

# Technical Details of X-20 Revealed

***Command & control methods, ground-controlled approach system also proposed***

**by Russell Hawkes**

LAS VEGAS, NEV.—Further technical details of the *Dyna-Soar* space vehicle were disclosed at the Air Force Assn. convention here. Also unveiled were probable command and control (C&C) methods by which the Air Force plans to bring the *X-20* and other manned space vehicles back to Earth.

The spacecraft, displayed without its transition sections and other jettisonable portions, is approximately 35 ft. long, with a 20-ft. wingspan. It stands about 8 ft. high. The configuration will be achieved at the jettison point of 4000 fps., when the last of the drop-away sections will fall away on the final landing approach.

The main transition section will carry a major portion of the fuel for operation of control jets during space flight.

Design features in the mockup included gaps between skin panels to permit expansion during re-entry heating; the jettisonable heat shield protecting the front windows of the cockpit; the unshielded side windows; the thick high-lift, high-drag delta wing, and the blunt-edged elevons and rudder/speed brakes.

The fin-and-tube heat radiator on the square aft end of the fuselage was not shown. Heat accumulated in the "water wall" frontal parts of the vehicle is carried to the empennage to be radiated through the squared tail surfaces.

The rudder/speed brake design is such that the slab-shaped fins can be turned in the same direction for directional control, or in opposite directions to act as speed brakes. Even in applying speed brakes, however, the degree to which each fin is deflected is controllable so that directional control is maintained.

Few control-jet ports were visible in the mockup, though several were indicated in the aft section of the vehicle. Others will be located in nose, wing and tail surfaces. Gradual transition will occur from reaction to aerodynamic control as the vehicle descends through the atmosphere.

Program officials said that other in-

flight control and propulsion after boost by the *Titan III* is provided by a Thiokol solid rocket located in the tail. Usable as either an acceleration device or an abort rocket, this unit develops 40,000 lbs. thrust for about 13 seconds—or enough to raise the 10,000 to 15,000-lb. glider about 10,000 feet off the launch pad during an abort so the pilot can assume a horizontal direction and execute an Immelmann maneuver to land on the Cape Canaveral skid strip at less than 200 knots.

In addition to the in-flight acceleration and on-the-pad abort functions, the solid rocket is expected to be used for corrective propulsion in the early phase glides after air-drop tests from a B-52. This phase is due to begin in late 1963 or early 1964.

The *X-20* pilot will not have an escape capsule, but instead will use a seat-type ejection system. Decision in favor of the seat was made when engineers decided the need for ejection in supersonic or hypersonic flight is "remote." The seat device accordingly is being designed for use at subsonic speeds.

Boeing officials and system test pilots noted that substantial growth capability is being built into the *X-20*, with a view toward possible performance of three or more Earth orbits and perhaps other missions. The first manned orbital flight in the *X-20* is tentatively scheduled for 1965.

*Dyna-Soar's* main landing gear will resemble wire brushes mounted on skis. This portion of the landing equipment is being built at Goodyear's Akron plant under a $45,000 subcontract to Boeing. Bendix is developing a retractable nose gear, resembling a shallow dishpan, under a $75,000 subcontract.

• **Improvements over X-15** — Improvements in aerodynamic design reportedly give the *X-20* a lift-to-drag ratio considerably better than the *X-15* and a similar advantage in heat-sink rate. The *X-20* will glide to earth from orbit in a relatively leisurely manner—with more than 30 minutes allowed for heat dissipation.

Unlike the *Mercury* astronauts, its pilot will experience no higher gravity loads than he would in landing a commercial jetliner. Aerodynamic and space-flight design concepts have been studied in tests in 30 wind tunnels, constituting virtually every major test facility of this type in the country.

Noteworthy design developments to solve heating problems in addition to metals developments include use of triangular-shaped girder arrangements permitting internal stresses to deform temporarily, but virtually eliminating thermal stress.

Proposed test sequence for *Dyna-Soar* includes (1) air drops of unpowered gliders from B-52 bombers; (2) later glider flights equipped with rocket engines to propel them faster than sound; (3) unmanned and manned orbital flights launched from Cape Canaveral.

Although specific requirements for military space command and control systems must await the definition of military space missions, the problem is analogous to the command and control (C&C) requirements for military aircraft.

• **Command and control**—Speaking at a panel on aerospace C&C at the AFA meeting, Maj. Gen. C. H. Terhune Jr., commander of Electronic Systems Division, AFSC, said space operations will intensify AF C&C problems but that the functions to be performed will remain essentially similar to those in the aeronautical environment.

Terhune pointed out that the existing ballistic missile early warning system and space detection and tracking system represent first steps toward a space C&C system. But he said true space C&C systems must rely on later generations of electronic developments.

The functions to be performed by the space C&C system include collection of information about physical conditions in space, such as the best paths through radiation belts, solar wind status, micrometeorite density, atmospheric factors affecting attenuation of visible light, first-orbit detection ability, identification, tracking and cataloging of all objects in space.

To perform these functions, sensors must detect objects with a reflective surface of less than a square meter. New radars such as the phased-array type are promising but may have to be supplemented by satellite-borne radar. Operations centers must also be able to evaluate the large quantity of information they will receive.

Equipment devised for this purpose, Terhune said, must permit existing Strategic Air Command and North American Air Defense Command operations centers to evolve in an orderly way. The centers must be integrated with the national military command system and must supply appropriate information to other government agencies.

The satellite test center at Sunnyvale, Calif., and existing military operations centers are already providing a first look at the space operation's technical problems. Technical control services comparable to present air traffic control services will be needed, including: control of launch, enroute operations, and recovery; high-resolution tracking; and a timely supply of status information.

• **GCA system proposed**—A ground-controlled-approach (GCA) system for returning spacecraft was proposed at the convention by Robert L. Schroeder of Raytheon as one of the mechanical control systems. It was pointed out that methods now used to control spacecraft are crude, unreliable and fearfully imprecise compared to the methods used to navigate and land current aircraft. If comparable operations are to become routine, then comparable standards must be achieved, Schroeder said.

The space GCA system proposed by Schroeder is far more elaborate than its aviation equivalent because equipment must operate over far greater distances, must cope with far greater speeds and must deal with such special problems as communications blackout caused by the plasma sheath during re-entry.

Like GCA, the system uses vehicle maneuverability to make larger position error acceptable at the beginning of the recovery operation. Unlike GCA, it may be necessary for the ground station to assume direct control of the vehicle in case the crew is disabled. It should also be capable of all-weather operation and simultaneous handling of a number of the vehicles.

The space GCA corridor could be about 8000 miles long with the entry gate over Australia for an instrumented approach to the Western U.S. from a low inclination orbit. The approach corridor for a polar orbit might be about 3500 miles long. Schroeder estimates that aerodynamic control can be phased in from 3000 to 9000 statute miles short of the landing site, as maneuverability is lost rapidly in atmospheric re-entry.

A space GCA system must have continuous real-time and advisory control at or before the time of entry. This will require an extensive ground tracking network tied to the control center by real-time ground data links. It would also relay onboard biomedical data and system status measurements telemetered to ground tracking stations.

In addition to conventional GCA functions, the system for space operations must: monitor many subsystems, predict the effect of malfunctions and determine error buildup and its effect on flight performance, test system performance, alter objectives and destinations when required by weather conditions or military requirements, take direct control of the vehicle during critical phases of the flight, use ground-derived data to assist in recovery when onboard navigation and computer subsystems have failed, and coordinate with Federal Aviation Agency and NORAD regarding arrival times and identification.

A priority coding system should be used, Schroeder added, to guarantee higher data rates for more critical and faster-changing quantities, as system design should emphasize reliability of transmission rather than quantity. ⌗

## Coercion Charged by N. Y. Firms

Long Island government and industry officials are protesting an alleged attempt by Temco Electronics and Missile Co. to coerce New York firms into relocating in Texas. The controversy could result in a congressional investigation.

Several Long Island companies privately admit having received copies of a letter signed by the Temco Electronics purchasing agent asking whether the firms plan any new facilities in Texas.

The letter closes with: "Our management feels it is important to have this information to guide our purchasing policies." This last statement gave rise to the controversy.

Though a Temco spokesman termed the letter an "innocent undertaking" in connection with a Dallas Chamber of Commerce campaign, Senator Kenneth Keating of N.Y. blasted the company for an "outrageous" attempt to "pressure N.Y. firms into Texas, if they expect to do business with this firm."

Keating plans to call on DOD and NASA for "special surveillance over any of [Temco's] subcontracts involving government funding."

## Lanphier Becomes Raytheon VP

Thomas G. Lanphier, who resigned as president of Fairbanks Morse & Co. recently, has become vice president for corporate planning at Raytheon. He will be responsible for all of the firm's corporate-level planning.

Lanphier is a former VP of General Dynamics/Convair and strong critic of the Eisenhower Administration's ballistic missile policies.

## Astropower Research Center Opens

Astropower, Inc., subsidiary of Douglas Aircraft Co., has opened its new $1.25 million, 40,000 sq.-ft. research and development center on 50 acres at Newport Beach, Calif. The center is devoted to projects in marine propulsion, energy conversion, rocketry, spacecraft electronics, information processing, intelligence transfer systems and materials research.

First construction phase, now complete, includes an 8000-sq.-ft. administration building and a 32,000-sq.-ft. engineering and laboratory structure. Ultimate plans call for 19 buildings with more than 500,000 sq. ft. of floor space, including a five-story administration building. A 35-acre test site 20 miles away complements the center.

## Computer Communication Installations

Thompson Ramo Wooldridge, Inc., has produced, installed and checked out a highly advanced man-machine communication system for Air Force Headquarters Command Post at the Pentagon. The system consists of two computer communication consoles (CCC) and a display interface buffer (DIB), both by TRW. It allows direct two-way communication between personnel and computer in English language terms. Buttons pressed on the console immediately produce answers on a TV-type screen. Operators need no special training. . . . *Martin Co. computer centers 1500 miles apart will be linked in December by long-distance phone lines and ultra-modern high-speed data transmission equipment. The centers, in Baltimore and Denver, support a variety of missile/space projects. Computer rental savings are expected to be at least $250,000 in the first four months.*

## SPSE Offers Tiros Details

Aerospace industry photographers attending the symposium on Electronic Display in Washington, Oct. 12-13, will learn new details of photographic capabilities of *Tiros VI*. Marvin Harper of RCA's Astro Electronics Div. will present a paper on techniques and equipment involved in taking and analyzing cloud map photos. The National Bureau of Standards and the Society of Photographic Scientists and Engineers sponsor the seminar.

## International News Notes

A Japanese military team is evaluating air defense control systems proposed by General Electric, Hughes Aircraft and Litton Industries for the U.S. Air Force, Marine Corps, and Navy, respectively. But the Japanese officials fear being "misled" by "political influence" here. Until now most equipment bought by the Japanese was designed for the Air Force. For the first time the team is evaluating gear developed for other U.S. services, and it fears undue AF influence in the recommendations it will carry back to Japan Oct. 28. . . . *Israel's official investment group is urging American firms to extend electronics production and marketing operations to Israel. The group is using a Stanford Research Institute report to persuade companies that Israel has favorable personnel resources and tax benefits for American firms, as well as a fast-growing local market for electronic products.* . . . The Lubrizol Corp., Cleveland, will break ground this month for its sixth overseas facility in the past decade. The new $3-million plant, to be built in England, will serve customers throughout the Commonwealth and in Scandinavia. . . . *Greer Hydraulics, Inc., Los Angeles, has named Okura Trading Co., Ltd., Tokyo, the sole Japanese distributor of Greer hydraulic accumulators and accessories. Okura is a well known distributor with sales and service branches throughout Japan and in nine other countries.*

# Attitude Control System Aids Re-entry

PASADENA, CALIF. — A lightweight, self-contained, closed-loop attitude control system designed to simplify guidance and control for spin-stabilized research rockets and probes has been developed by the Whittaker Controls and Guidance Div., Telecomputing Corp.

Whittaker engineers believe the system is a logical growth in the state of the art based on company experience in *Nike-Ajax, Nike-Hercules, Shillelagh, Bullpup,* and the *Agena* attitude control system.

A pre-alignment capability makes the system appear well-suited for programs where re-entry angle is a critical factor. The angle can be "tuned in" just before launch with instructions to program the payload to the desired re-entry angle at a pre-calculated position in space. A "last-stage" rocket would then be fired, accelerating the payload to the proper re-entry velocity.

For test missions involving star tracking or horizon scanning, the attitude control system can be pre-tuned to program a flattened top portion of payload trajectory—providing a temporarily stabilized platform.

The system weighs less than 25 lb. and consists of two basic modules. A primary module is fitted to the payload end nearest the booster. It contains the attitude reference, electronic controller, battery, gas receiver, squib valve and pressure regulator. The secondary module, fitted to the payload section's opposite end, contains a relief valve, pressure transducer, gas nozzle and electrical connectors.

Both modules could be contained in a single package to meet space restrictions of a specific vehicle. In the two-module version, the packages are connected by a short length of tubing and an electronic cable, with an additional cable tying the electrical system to the umbilical.

• **Attitude reference section** — The attitude reference unit is a three-axis gyro system accommodating 360° of rotation about two axes, and ±190° about the third. System employs two free gyros on a roll-stabilized gimbal. A driving servo isolates the gyros from vehicle spin. System size and weight is actually less than a pair of body-mounted free gyros capable of comparable performance only in absence of spin.

The roll reference gyro is mounted to a roll-stabilized gimbal, with its outer axis parallel and its inner axis perpendicular to vehicle roll.

Any rectangular disturbance to the roll-stabilized gimbal—such as friction coupling across the main roll bearing that supports it—produces a signal output from an ac variable-reluctance pick-off mounted on the roll reference gyro's outer axis. The signal is amplified and applied to the control phase of an inertia-damped, two-phase gear head servo motor fixed to the stabilized frame.

The servo can overcome combined environmental effects, including maximum vehicle spin rate, thrust accelerations and solid-rocket vibration. Vehicle roll is registered and read out as rotation of the outer housing relative to the fixed roll-stabilized frame. Vehicle rotation about this axis is similarly indicated on the gyro's inner axis.

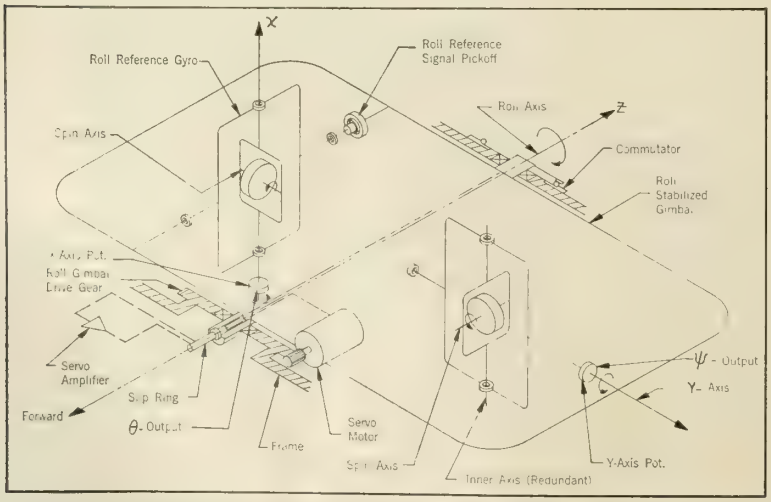
A Y-gyro is mounted alongside the roll reference gyro on the same stabilized frame, with its outer axis parallel to Y. Isolated from vehicle spin, it can indicate vehicle rotations about Y over a full 360°. The axes of both gyros and the roll-stabilized frame on which they mount are caged mechanically relative to the housing through an integral, electrically operated cage/uncage mechanism on the frame.

The unit is installed in the attitude control system module with the caged Y-axis aligned perpendicular to the predetermined plane (not necessarily the trajectory phase) in which the attitude is to be made. With this approach, attitude rotation is taken up about the Y-gyro's outer axis which can accommodate a full 360° rotation. It can also accommodate desired attitude changes with no impairment of reference system accuracy. Roll reference in this situation will absorb the attitude rotation about its spin axis.

• **Vehicle rotation** — Potentiometer pickoffs on the Y-axis of the Y-gyro and X-axis of the roll reference gyro generate input signals to the total attitude control loop. The system then rotates the vehicle about the Y-axis to an attitude where the Y-axis potentiometer output is in bridge-balance with an external, manually preset "Y-rotation" control.

The system also rotates the vehicle about the X-axis to a null position on the X-axis potentiometer. Potentiometer signals are fed through lead networks, then amplified and connected to four segments of a case-mounted commutator on the reference unit's roll axis.

The wiper contacting the segments.




*SCHEMATIC of Whittaker's attitude control system discloses simplified design detail.*

mounted to the roll-stabilized gimbal, provides X and Y-axis signals from the two gyros to the body-mounted single nozzle. The wiper may be manually rotated before final installation to properly "phase" the commutator.

For each shot, the reference unit is installed about the roll axis so the Y-gyro outer axis is perpendicular to the plane in which the attitude rotation will be made.

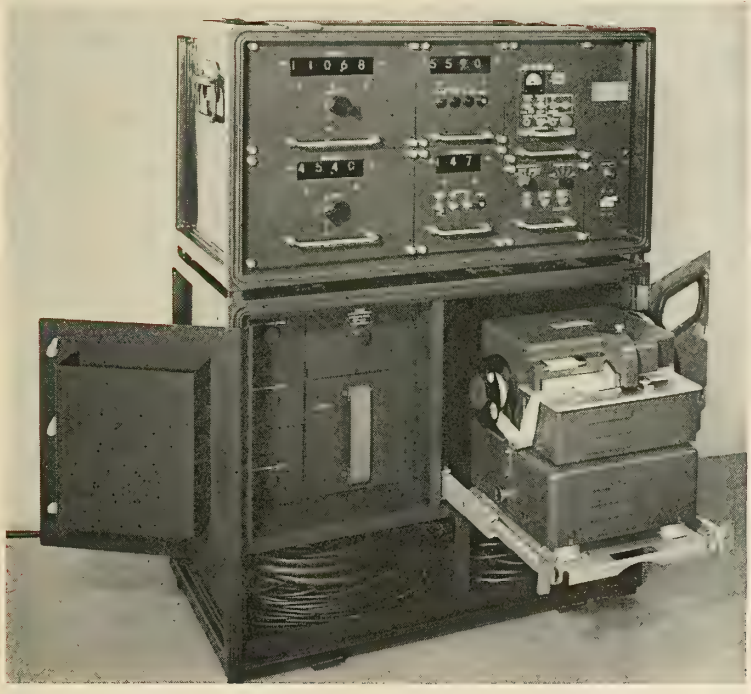
• **Reaction control system**—Whittaker selected a Freon 14 cold-gas system over other types of reaction-control methods because of its simplicity, reliability and relative safety for the required total impulse of about 150 lb. sec. The single nozzle is oriented with a thrust axis perpendicular to the spin axis and about 60 in. from the CG for bi-directional pitch and yaw control.

For use in a typical *Nike-Javelin* type system, nominal pulse rise and decay time is five millisec. Maximum pulse length is 60.0 millisec, representing an arc subtended by a roll angle of about 60° at the minimum spin rate of 2.75 rps. Minimum pulse length of 35 millisec. represents a similar angle at the maximum tolerable spin rate of 4.75 rps.

The nozzle produces a nominal thrust level of 7.5 lb. to provide the necessary impulse per pulse, which decreases directly with the spin rate. This produces a constant mean thrust value for the steady state "ON" control condition. By varying thrust level pulse duration and values, the system will operate at spin rates from 0.5 rps to 20 rps. Lower limitation is due to system response requirements. High limits are due to mechanical limitation of the valve response.

Two adjustments are required before system installation in a vehicle. These determine the direction in space to which the attitude system orients the vehicle. Orientation, relative to the rocket body, of the plane in which attitude rotation will be made, is determined by attitude reference mounting.

Provisions are made to rotate the unit to a pre-determined orientation about the roll axis. Desired angle is read on a dial on the attitude reference unit's housing. Desired final attitude within this plane is set manually on the Y-rotation control potentiometer. ⌘



## New Product of the Week:

## Digital Radiosonde Converter

A data conversion system designed for use with weather balloon tracking—using the latest state-of-the-art digital data techniques to provide continuous information to a battlefield computer—is available from Datex Corp. Known as Datex DV-772 Radiosonde Data Converter, the system uses a radiosonde, tracking antenna, data converter, field computer, tape punches and radiosonde recorder.

The system is expected to reduce the staleness of meteorological data by increasing data acquisition and processing rates. The system will permit evaluation of current automation techniques in radiosonde data systems. Atmospheric parameters consisting of temperature, humidity and pressure are measured and recorded. The system also provides information permitting prediction of radioactive fallout patterns.

Circle No. 225 on Subscriber Service Card

## Power Converter

A half-wave, variable-frequency power converter is available from Pioneer Magnetics, Inc. The P.M.I. converter operates from a 28-volt dc power source and produces 350 volts square, half wave output power (other voltages upon request). The output is used to power a telemetry transmitter. By applying half wave square waves to transmitter, battery life of the space vehicle is nearly doubled. Even greater economy is available by reducing the "on" to "off" time ratio of the converter output.

The converter frequency can be linearly varied over a very wide frequency range by means of a very low level electrical signal. These frequency ranges are as high as 10- or 20-to-1. Speed of response of the output frequency to a change in input signal is less than ½ cycle.

Circle No. 226 on Subscriber Service Card

## Electronic Switch

Model ES 1060F Electronic Switch Units, using solid state components and printed circuitry to provide high-speed switching of electrical circuits, are offered by G.P.S. Instrument Co. Time to go from normally-closed to normally-open positions (pick-up time) is less than one microsecond, and from normally-open to normally-closed (drop-out time) is less than two microseconds. The coil input is a transistorized circuit triggered by a positive signal of any voltage from 5 to 20 volts. (Twelve volts is normal.)

Circle No. 227 on Subscriber Service Card

## Ultrasonic Flaw Detector

Curtis-Wright Corp. is marketing the Echoscope Mk-7 Flaw Detector, which features extremely high near-surface resolution. The unit easily detects a

1/32-in. flaw at 0.90-in. below the surface. Choice of contact or immersion inspection techniques and testing frequencies of 0.6, 1.5, 2.5 and 10 mc provide usefulness over an exceptionally wide range of applications. Time base speeds vary between 10 and 2500 microseconds for testing materials from 1-in. to 25-ft. in depth.

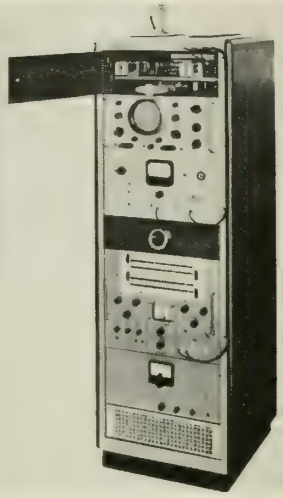
Circle No. 228 on Subscriber Service Card

## Phase Measurement System

A phase measurement system—designed to determine with extreme accuracy phase shift and deviation from phase linearity of microwave components—has been developed by Rantec Corp.

Designed to provide rapid, accurate phase measurement of both active and passive components and subsystems, the equipment is adaptable to perform a variety of measurement tasks. Resolution and repeatability are on the order of 0.1°, with accuracy independent of amplitude and attenuation variation.

With three types of readout—meter, swept oscilloscope, and x-y recorder plot—the system can be used for such



measurements as phase vs. frequency and phase vs. a variable parameter (such as a control voltage).

Circle No. 229 on Subscriber Service Card

## Rectangular Connector

The Deutsch Co., Electronic Components Division, has available its "500" line of miniature rectangular connectors. Both the 500C and 500D series are primarily for industrial and non-environmental military use.

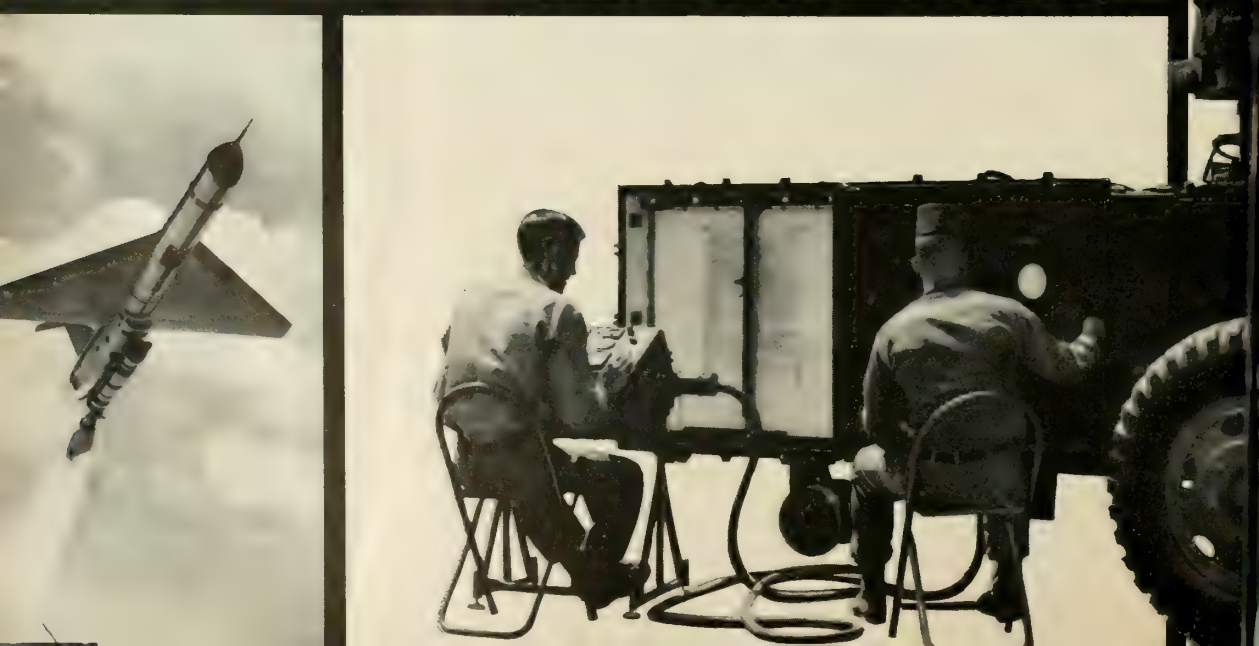
Features of the 500 line are flush, straight-hood, or right-angle-hood mounting plugs, with surface or flush-mounting receptacles. Coupling method is by guide pin and short, stationary, and center jackscrews. Crimp terminated contacts may be intermixed in the same configuration, available in sizes 16 and 20, and are adapted to automatic crimp methods. The connectors are available in 14, 18, 20, 26, 34, 41, 42, 50, 66, 75 and 104 contact form with guide pin, short and stationary jackscrews. Center jackscrew units are available with 100 and 200 No. 20 contacts.

Circle No. 230 on Subscriber Service Card

## Test Point Connector

A 5-contact miniature test point connector is available from Lionel Electronic Laboratories, Inc. The unit is being marketed in two types. One for dip soldering to a printed circuit board where there is a need for a device which can be permanently incorporated in a printed circuit and provide an easy method of getting voltage readings at critical points in the circuit. Socket contacts are made for use with an 0.030-in. probe and are recessed below surface


A perfect surveillance system
...from launch to recovery



of molding. To help withstand vibration, contacts are designed to float in molding.

The second type is designed for easy surface mounting and maximum flexibility when relocation is necessary. They can be ganged in rows or back to back.

Circle No. 231 on Subscriber Service Card

## Solid-State Accelerometer

Self-generating accelerometer, Model 32, developed by United Electronics Corp. contains no wires, jumper strips, or solder. Each unit temperature-cycles to stabilize sensitivity. Other features are choice of stick-on or insulated integral stud mounting and spanner-wrench holes provided for deep-hole installation. High 30-millivolt-per-g output coupled with high internal capacitance of 1300 picofarads permits investigation with minimum electronic equipment.

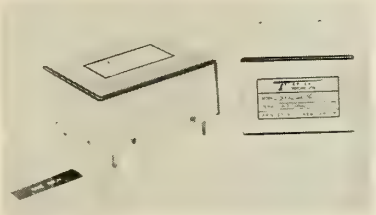
Circle No. 232 on Subscriber Service Card

## Sawtooth Generator

A sawtooth generator available from Alfred Electronics provides sawtooth signals for modulating helices of traveling wave tubes for generating Doppler shift. Positive- and negative-going sawtooth voltage signals are simultaneously available, allowing simultaneous operation of two microwave amplifiers. Repetition rate is adjustable from 0.1 cps to 1 mc. Flyback is less than 1% or 70 nanoseconds and amplitude is continuously adjustable from 0 to 60v peak-to-peak.

Circle No. 233 on Subscriber Service Card

## Sampling Switch



Teleplex Corp. offers a product line of high-level, electronic commutators and multicoders. The type 300 units—modular assemblies with overall transfer accuracy of 0.1%—incorporate all-silicon solid state devices. Low back current of ±1 microampere permits sampling of sources as high as 50K ohms. Standard output formats, per IRIG Telemetry Standards, are PAM, PDM and simultaneous PAM/PDM. An optional record output is available for any unit with a PDM output format for direct entry into a tape recording head. Input power in approximately 60 milliamperes from a 28-volt dc source. Volume is about 28 cu. in. for a 90-channel assembly.

Circle No. 234 on Subscriber Service Card

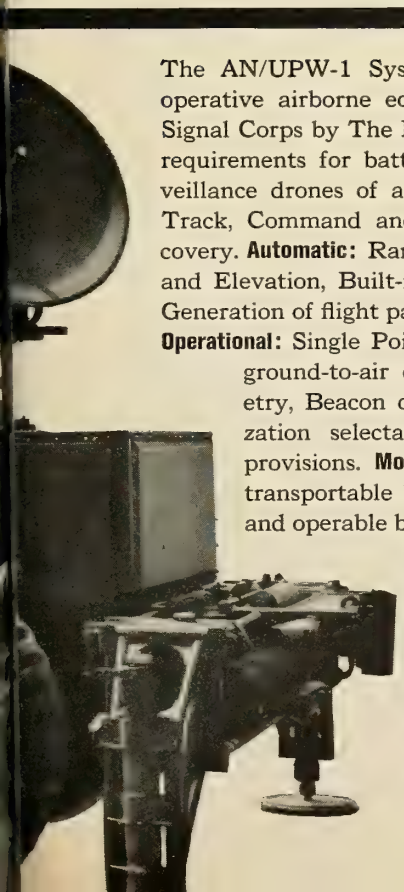
## Pulser Line

A line of extremely reliable pulsers is available from System Design, Inc., a division of Guide Mfg. Co. The pulse, Series 1013, is designed to operate at all power levels. Pulse rate at either on or off-time, to and from, is completely reliable between 1/12 of a second to 100 seconds. Input is 24-30 volts, dc, with SPCT output. Units operate within a temperature range of 0° to 70°C.

Circle No. 235 on Subscriber Service Card

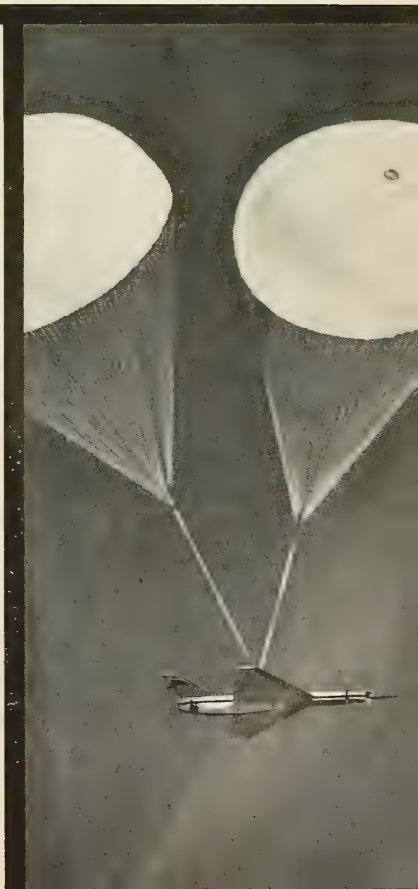
## Variable Attenuator

Weinschel Engineering is adding a direct reading continuously variable attenuator to its precision line of coaxial components. The Model 905 is continuously variable up to 10 db and covers the frequency range from dc to 1 gc. It is rated for a power input of 1 watt cw and has a maximum VSWR of 1.25 to 500 mc and 1.50 to 1 gc. The model 905 is direct reading over the

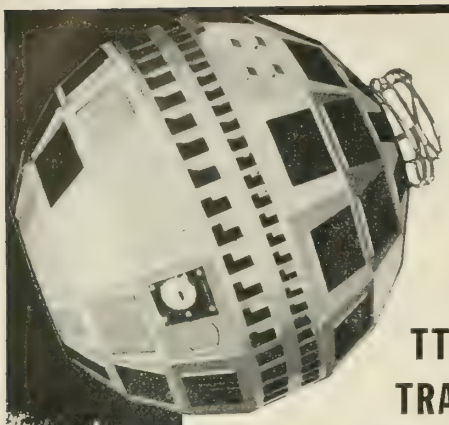



The AN/UPW-1 System, comprised of ground and co-operative airborne equipments, developed for the Army Signal Corps by The Ford Instrument Company, meets all requirements for battlefield remote control of aerial surveillance drones of any type. **System Capabilities:** Launch, Track, Command and Control, Telemetry, Plotting, Recovery. **Automatic:** Range Lock-on and Tracking, Azimuth and Elevation, Built-in permanent Trace Plotting Board, Generation of flight path correction signals, Return to Base. **Operational:** Single Point Radar Tracking System, Integral ground-to-air command link, Air-to-ground telemetry, Beacon or skin-track modes, Antenna polarization selectable by operator, Built-in anti-jam provisions. **Mobility:** Fully integrated system easily transportable by ground or air, Completely set up and operable by two men in less than one hour. **Field Tests:** Army conducted tests have demonstrated: **1.** High Accuracy. **2.** Reliable tracking at extremely low angles and at extended ranges. **3.** Ability to pass Munson Road Test.

**FORD INSTRUMENT CO.**
DIVISION OF SPERRY RAND CORPORATION
31-10 THOMSON AVENUE, LONG ISLAND CITY 1, NEW YORK



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# TELSTAR PROVEN

## DEI'S TTR-2 MONOPULSE TRACKING RECEIVER

The TTR-2 was designed and developed for the BELL LABORATORIES TELSTAR Communications Satellite Tracking System



The capabilities, experience and product knowledge devoted to this and other important space projects are leading to new techniques and new hardware to meet the constantly changing requirements of the Space Electronics and Telemetry field. If yours is a problem of communications, DEI can assist with engineering, basic components or complete systems. For descriptive literature on this and other outstanding DEI products and systems, write, wire, or phone:



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entire range of frequency and attenuation. The dial is calibrated directly in db insertion loss at the center frequency of 500 mc. Small db correction factors for DC, 300, 750 and 1000 mc are indicated on a correction table permanently affixed to the front of the unit.

Circle No. 236 on Subscriber Service Card

## Miniature Capacitor

A miniature tubular capacitor with weldable leads for cordwood packaging has been developed by Gulton Industries, Inc. Capacitance values range from 10 to 1000 mmf in tolerances of +5%, +10% and +20%. The capacitors are rated at 50 vdc over a temperature range from −55°C to +150°C. The Glenco tubular capacitor exceeds requirements of military specifications MIL-C-11015B. Test data are available upon request.

Circle No. 237 on Subscriber Service Card

## Gyro Table Servo

An all solid-state gyro table servo is available from Solid State Instruments Corp. for gyro testing and positional test table applications. The servo includes an ac amplifier, demodulator, reference voltage amplifier, and phase shifter, optional tach amplifier, high power dc amplifier and power supply. No M-G set is required. Excitation frequency range is from 800 to 5000 cps. Filters and a selector switch for any four operating frequencies is optional. The servo contains a compensation selector which allows stable servo operation over a range of gyro time constants from 0.5 to 200 msec.

Circle No. 238 on Subscriber Service Card

## High-Purity Raw Materials

Engineered Materials is marketing four basic raw materials for use in electronic ceramics, drugs, ferrites, and other industries requiring the highest possible purity. These ultra-high purity materials are; manganese dioxide; calcium carbonate, barium carbonate, and aluminum oxide.

Circle No. 239 on Subscriber Service Card

## Solenoid Rotary Switch

A totally enclosed, 12-position, 5-pole, solenoid operated rotary switch is available from Janco Corp. Called the Series 2055, it withstands such severe environmental conditions as high altitude, corrosion, humidity, sand, dust and fungus.

The switch features a self-contained interrupter mechanism coupled with homing capabilities for automatically

stepping to a predetermined, manually selected master position. Stepping speed is faster than 24 steps per second. An electrostatic shield for signal isolation is optional.

Power handling capacities are up to 5 amps (115 vac) and 3 amps (28 vdc) resistive, and 2 amps (28 vdc) inductive. They are rated to make, break, and carry.

Circle No. 240 on Subscriber Service Card

## Telemetry Oscillator

Sonex, Inc., has announced availability of an all-solid-state, high-environmental, millivolt-controlled/oscillator, specifically developed for telemetering millivolt signals in aircraft and missile applications.

The unit eliminates need for a costly high-gain dc amplifier in addition to a sub-carrier oscillator. Transducer voltage of only ± 10 mv is all that is needed to obtain high level output with 100% D.B.W. deviation. Floating-type input allows no restrictions on dc common mode voltages between differential inputs and ground.

Linearity of ± 0.5% from best straight line and input impedance of 50K are maintained for 0°C to +85°C. Center frequency is also stable to within ±0.5% D.B.W. over the temperature range.

Circle No. 241 on Subscriber Service Card

## Miniature Switch Package

A subminiature switch package built around the world's smallest hermetically sealed, snap-action switch is available from Metals & Control Inc., a corporate division of Texas Instruments, Inc.

Designated the Klixon AT4-2, this 1.25-in. long SPDT plunger-actuated switch provides ⅛-in. overtravel, weighs 10 grams with mounting hardware and has a current rating of 3 amp resistive with operating life of 15,000 cycles at full rated load and overtravel. It is available with or without potted leads and "ice breaker" type plunger.

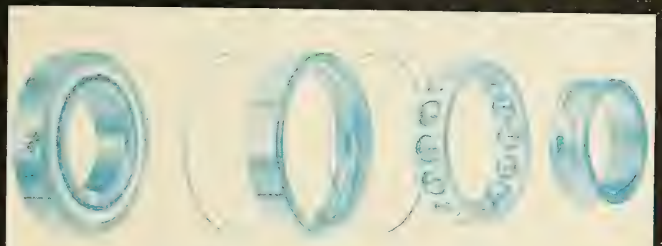
The ¼-in. 32-threaded neck of the AT4-2 provides simple installation and calibration in valves, actuators, launching systems and arming devices.

Circle No. 242 on Subscriber Service Card

## Voltage References

Miniature solid-state voltage references—designed for printed circuit board mounting or tube socket plug-in for applications in dc control circuits, guidance systems, digital voltmeters, potentiometric circuits, analog to digital converters, and special instrumentation


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—are available from Dynage, Inc. Series 230 units provide approximately 10 ma. at output voltages of 6.2 or 11.7 vdc. Series 210 units provide 1 ma at outputs of 6.2, 11.7 or 17.9 vdc. Temperature coefficients of ±0.001%/°C and ±0.0005%/°C are available. Voltage regulation is ±0.001% for ±10% change on inputs of 30, 38 or 46 vdc depending on the model. Long term stability is ±0.005% or better.

Circle No. 243 on Subscriber Service Card

## Wire-Wound Resistors

Ohmite Mfg. Co. has expanded its stock of molded wire-wound precision-power resistors, Type 883. The resistors now stocked range from 1.00 to 178.00 ohms in steps based on the MIL-Bell system of standard values for 1% tolerance. Over this range, Ohmite says it can supply 505 values in steps close enough to satisfy virtually every precision circuit need.

Wattages of the resistors, rated at 25°C ambient, include three-, five- and 10-watt ratings depending upon resistance. The resistors can be used at ambients considerably above 25°C with derating and at wattages more than sufficient for most precision applications. All units are aged for long-term stability and feature a low temperature coefficient of resistance.

Circle No. 244 on Subscriber Service Card

## Signal Sampling Network

Designed for use with high-power transmitters, a broadband signal sampling network that measures spurious and harmonic signals with ± 3 db accuracy has been introduced by Electromagnetic Technology Corp. With an optional zero-db coupler, Emtech's direct-reading instrument can monitor such signals while the fundamental frequency is coupled to the antennas.

The Model SSN also measures the full tube power output calorimetrically with 5% accuracy. Using a high-power water-cooled attenuator, the high power of the transmitter is attenuated equally for all propagating modes.

Emtech's mode mixer employs a time-sharing mode alignment technique to assure accurate measurement of the total power carried in the various waveguide modes. Harmonic frequencies are coupled on separate terminals by a band separation filter (second and third harmonics standard, higher orders on request).

Normal bandwidth for the SSN system is 15% centered to customer's specification anywhere in the waveguide band. Greater bandwidth available on special request.

Circle No. 245 on Subscriber Service Card

## Semiconductor Test Set

A semiconductor test set known as the Model "D", that measures the thickness of slices at the same time that it measures their resistivity, is available from Semimetals, Inc.

The equipment should aid in classifying slices of semiconductor material, because it gives simultaneously the two readings needed to calculate absolute resistivity of the material being tested. The thickness reading is obtained by a fifth needle in precision measuring head, in addition to the four probes used to measure resistivity. The thickness reading is presented visually on a zero-centered gage, which has a resolution of 1/20 of a mil per division.

Circle No. 246 on Subscriber Service Card

## Voltage Comparator

The Model T283 Voltage Comparator—a fast, accurate unit that operates an internal relay when signal input voltage exceeds a pre-set limit—is available from Avtron Manufacturing, Inc.

The T283 can be used for "go, no-no" testing, automatic inspection of checkout, limit detection, voltage calibration, process monitoring, decision-making and enunciation, etc.

The unit compares two input signals, one of which may be a reference voltage, and operates the output relay when the first voltage exceeds the second. The repeatability of the trip point and the difference between pull-in and drop-out is less than millivolts. A modified model (T283A) omits the relay; output is a dc voltage that changes abruptly from 0 to 9 volts.

Circle No. 247 on Subscriber Service Card

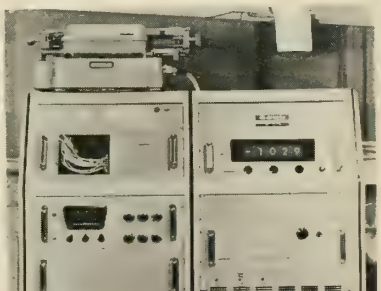
## Terminal Crimping Press

Designed for more efficient production in crimping solderless terminals and connectors on wires, a new-air-operated press has been introduced by ETC, Inc. Unlike other bench-mounted presses, the press has a "slanted" design. Ram, die-holders and crimping dies are slanted 30° rearward, giving the operator an unobstructed view of the crimping operation.

Known as the Model AP2-100, the ETC press is actuated by an electric safety foot-switch, freeing both hands to speed production. When electric power to the switch is cut off, the press cannot be actuated. Air pressure may be safely left on.

Circle No. 248 on Subscriber Service Card

## Digital Data Logging System



A digital data logging system to measure and indicate pressures, temperatures and flow in an atomic reactor has been developed by Cohu Electronics, Inc., Kin Tel Division. The system accepts analog signals from as many


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as 400 two-wire circuits and automatically selects one of three pre-set differential dc amplifiers to provide signal conditioning either in the form of amplification or of linearization.

Included as components in the Kin Tel Data Logger are the 864 solid-state digital voltmeter and three 114C differential dc amplifiers plus a power supply, signal conditioning switch, patch panel and a parallel-to-serial converter. Crossbar scanner, digital clock and electric typewriter complete the system.

Circle No. 249 on Subscriber Service Card

## Rotary Multipot

The Model 349 Rotary Multipot developed by Daystrom, Inc., provides a reliable low-cost adjustable multi-turn trimmer potentiometer in a rugged, compact package. Patented pressure-type terminal connections are used in a low-cost rotary potentiometer, contributing all the advantages of this time tested technique.

Three-, five- or ten-turn trimmers are offered in the same standard case. This feature simplifies the problems of the circuit designer, accounts for potentiometer economy and speeds delivery. Resistance of the Model 349 Multipot runs from 25 ohms to 1 megohm. Power rating of three watts in still air is maintained over an operating temperature range of from −55° to +105°C.

Circle No. 250 on Subscriber Service Card

## Cable Jacket

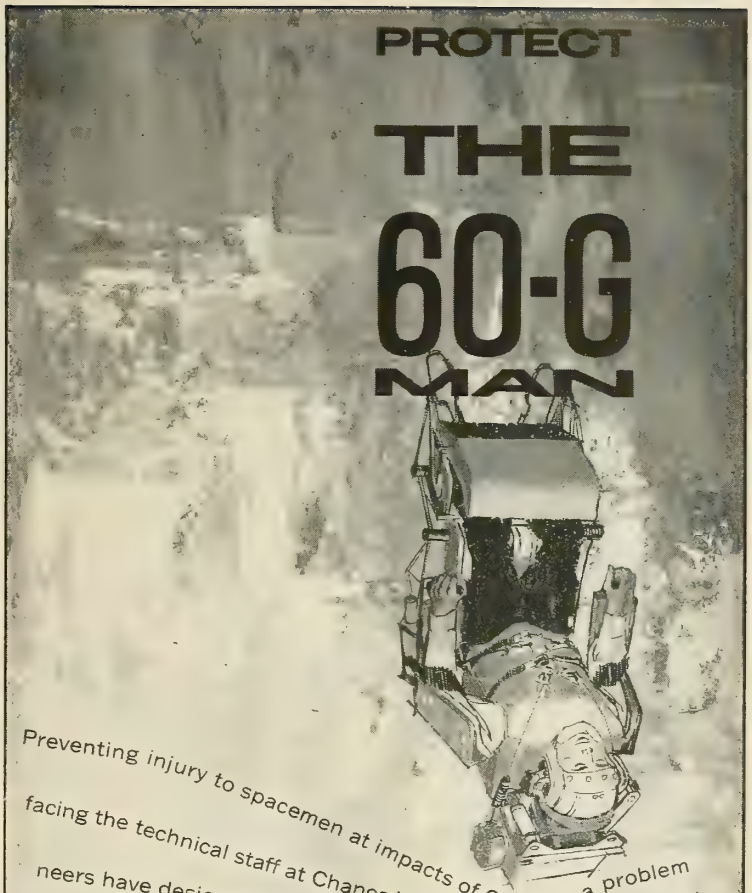
A technique of constructing cable jackets for large high-temperature Teflon cables is now available in a braided Teflon construction from Hitemp Wires Co. This jacket enables the user to rate entire cable at the same operating temperature (260°C) as primary Teflon conductors. It is also highly flexible and abrasion resistant.

The entire jacket can be color coded readily, either with various solid colors or with color tracers. Over-all cable diameter and weight can be reduced with this jacket—as compared to conventional elastomeric jacketing materials used on large-diameter cables. With new braided design, jackets can efficiently replace the more standard cable coverings.

Circle No. 251 on Subscriber Service Card

## Digilab Due

A model of the Digilab will be available soon from Tech-Serv. Inc. The Digilab is designed to provide a single integrated console containing all components required for breadboarding digital networks or laboratory instruction in digital elements and techniques.

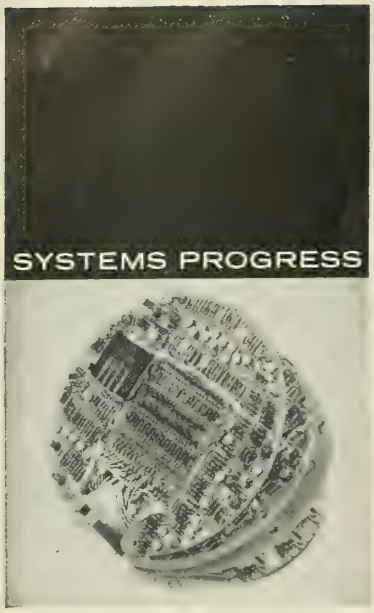




Preventing injury to spacemen at impacts of 60 g's is a problem facing the technical staff at Chance Vought. Already, Vought engineers have designed an armor-like experimental restraint system intended to keep man unharmed in hard landings and from accelerations which could be fatal with current systems. Still, this is just one of Vought's projects requiring skilled and imaginative scientists and engineers . . . like you, perhaps. Current programs include SCOUT, SATURN, CRUSADER, V/STOL. If you are ready to meet the challenge, look into openings with Vought, an aerospace leader offering opportunities for a full and rewarding future in: ***DYNAMICS*** Flutter and vibration, acoustic and vibrational environments, control dynamics and fluid mechanics. ***AERODYNAMICS*** Aircraft, missile or launch vehicle configuration design, stability and control, airloads and aerodynamic heating. ***POWER AND ENVIRONMENT*** Provide solutions to problems relating to thermodynamics, heat transfer and fluid flow from preliminary design through production follow-up. ***ELECTRONICS*** Electrical power generation systems applicable to missile electrical systems; electro-optics; inertial reference systems for guidance and control; ground support equipment; major RF systems; systems analysis of complex digital and analog equipment and analysis and/or design of guidance computers for airborne applications. Submit your resume to Professional Placement, Dept. MR-10, P.O. Box 5907, Dallas 22, Tex.

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SATELLITE PERFORMANCE ON COMMAND

One result of CSC's Space Sciences program is the Digital Command Decoder System. Carried aboard a satellite, this system decodes digital commands from the satellite receiver and actuates relays to perform any selected satellite function. Commands can be sent to as many as 112 satellites.

Less than 6½ inches in diameter and weighing 2.7 pounds, the system incorporates design features to assure accurate decoding, minimize the possibility of error, and safeguard against interference from noise. Circuitry is specially designed to be non-conducting in standby. When tone bursts are not being processed, only the leakage current of the transistors is drawn.

Other examples of CSC's growing role in the space program include analytical instrumentation, testing, checkout and support systems. In electro-optical, data-handling and industrial control areas, CSC is also developing new concepts in custom-engineered systems. For an explanation of how this experience can be applied to your field of interest, call your regional engineering representative or write:

CONSOLIDATED SYSTEMS CORPORATION

1500 So. Shamrock Ave. • Monrovia, California

Circle No. 15 on Subscriber Service Card

The unit features a built-in regulated, short-circuit-proof power supply. Mounted on the console are 40 DigiBits —transistorized digital logic elements (the same computer-type packages used in the industrial and medical electronics field). The logic elements supplied are one-shorts, flip-flops, inverters, clock, indicators, diode AND gates, R-C AND gates, OR gates, and control packages.

Circle No. 252 on Subscriber Service Card

## Off-Axis Paraboloids

Farrand Optical Co. has developed off-axis as well as centered paraboloids. Full paraboloids are available in diameters up to 30½ in. and focal length to diameter ratios down to 0.14.

These mirrors offer new possibilities in energy relay systems because the foci are located outside the energy path. They are for laser pumping, light radar, detector optics, communications, etc. A typical off-axis paraboloid available from stock has a full 71° acceptance angle, a beam diameter of 7.7 in., a circle of confusion of less than 0.006 in. and the focus is 1¼ in. from the parallel beam.

Circle No. 253 on Subscriber Service Card

## SPDT Switch

Micro State Electronic Corp. is producing a high-power solid-state SPDT switch, Model S1301, with an operating bandwidth of at least 70 mc in the L-band region.

Built with Micro State diodes, the Model S1301 is designed to operate at 1 kw peak power, 10 watts average. Isolation is better than 35 db, and insertion loss less than 1.3 db.

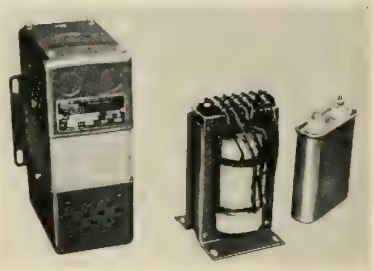
The switch's low-voltage drive requirements simplify its incorporation into systems. Drive requirements are −30 volts for transmission and 1.3 volts at 50 Ma for isolation under high power. D-C bias can also be supplied so that a unipolar video drive would be sufficient to trigger the switch. Switching time is less than 50 nanoseconds.

Circle No. 254 on Subscriber Service Card

## Constant Voltage Transformer

Sole Electric Co., a division of Basic Products Corp., has developed a line of 400 cycle constant voltage transformers. Available in the 60-1000 va range, the 400 cycle CVS features completely automatic, continuous regulation, fast response time, no moving parts or manual adjustment and compact size and weight.

Electrical characteristics of the 400 cycle transformer are: 118 v regulated



output ±1% nominal tolerance, ±load regulation from full load to no load, input range (95-130v) 115 v nominal and 3% total rms harmonic distortion.

Circle No. 255 on Subscriber Service Card

## Pulse Modulator

A 1.2 megawatt hard tube pulse modulator designed to operate microwave power tubes is available from Radiation Inc. The Model 344M is designed for pulsing klystrons, magnetrons, traveling-wave tubes or any electron device requiring the high voltage negative pulses demanded by today's high power microwave systems. Its universal design also permits the unit to be used as a tube test modulator and a life test modulator. It operates from an input of 208 volts and 9-kva. The dc power supply portion of the modulator can be used separately as a continuously variable source of power up to 45 kv and 150 ma.

Circle No. 256 on Subscriber Service Card

## (TM) Stimuli Generator

A Servopulse (TM) stimuli generator has been developed by Servo Corp. to provide all the signal necessary for testing standard logic cards and many special analog circuits. These include two independent pulse trains, with pulse repetition rate from 200 cycles to 2 mc., a 10-volt sine wave, with frequency range of 18 cycles to 1 mc. The 22 kc sine wave output is available at two jacks; one a reference, the other variable in phase a full 360° with respect to the reference. The 22 kc output can be modulated by the pulse generator output to give a pulse or square wave modulated 22 kc sine wave.

Circle No. 257 on Subscriber Service Card

## HF Transducer

A series of high frequency continuous phase-shifting transducers operating at a specific user frequency in the range 5 MC/S to 50 MC/S has been developed by Nilsen Mfg. Co. The unit produces continuous time delays or phase variations from 0° thru 360°.

Circle No. 258 on Subscriber Service Card

# contracts and procurements

## AWARDS

### AIR FORCE

$14,000,000—**Martin Marietta Corp.,** New York City, for installation and checkout of *Titan* missile complexes. Work to be done at Ellsworth Air Force Base, Mountain Home Air Force Base, Larson Air Force Base and Beale Air Force Base.

$7,000,000—**General Electric Co.,** New York City, for work on space vehicles. Work to be done at Philadelphia.

$6,000,000—**Martin Marietta Corp.,** New York City, for research and development on vehicles for a space program (supplemental contract). Work to be done at Baltimore.

$5,150,000—**International Telephone and Telegraph Corp.,** New York City, for fabrication and delivery of electronic equipment (supplemental contract). Work to be done at Paramus, N. J.

$4,150,000—**Radio Corp. of America,** New York City, for work on the Ballistic Missile Early Warning System. Work to be done at Moorestown, N. J.

$3,000,000—**General Dynamics Corp., Astronautics Div.,** San Diego, Calif., for *Atlas* missile program (supplemental contract).

$2,500,000—**Boeing Co.,** Seattle, Wash., for work on *Minuteman* weapons system at Seattle and Vandenberg Air Force Base.

$1,472,065—**Marquardt Corp.,** Van Nuys, Calif., for work on a classified project (supplemental contract).

$1,108,000—**Martin Marietta Corp.,** for continued work on communications systems for *Titan* intercontinental missiles at Denver, Colo.

$1,105,790—**Vickers, Inc.,** Detroit, Mich., for spares for *Hound Dog* missiles.

$1,100,000—**Emerson Electric Manufacturing Co.,** St. Louis, Mo., for classified project (supplemental contract).

$740,000—**Quantic Industries, Pelmec Div.,** San Carlos, Calif., for production of standardized safe-arm igniter mechanism for *Minuteman* missiles.

$225,000—**Garrett-AiResearch,** Los Angeles, Calif., for research and development of a closed loop cryogenic cooling system.

$170,933—**Astropower, Inc.,** Costa Mesa, Calif., for a study of compatibility of various metals with high-energy rocket propellants.

### ARMY

$1,222,300—**Hughes Aircraft Co.,** Fullerton, Calif., for missile monitor equipment.

$100,000—**Radiation, Inc.,** Melbourne, Fla., for a portable telemetry system to measure physiological data.

**Computer Sciences, Inc.,** Los Angeles, Calif., for research and development in preparation of tactical program tapes pertaining to *Honest John* rocket systems (undisclosed amount).

### NAVY

$31,206,271—**Westinghouse Electric Corp.,** Pittsburgh, Pa., for design, development and supply of reactor motors for a nuclear powered ballistic missile submarine fleet.

$10,544,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for continuation of research and development on the *Subroc* missile system.

$7,044,637—**Raytheon Co.,** Waltham, Mass., for *Sparrow III* missiles.

$3,000,000—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for *Polaris* test vehicles and motors.

$73,129—**Chrysler Corp.,** Detroit, Mich., for research and development concerned with launching large solid rockets from ships at sea.

### NASA

**International Telephone and Telegraph Laboratories,** Fort Wayne, Ind., for 8 satellite automatic tracking receiver systems (undisclosed amount).

### DOD

**International Telephone and Telegraph Corp.,** Washington, D. C., for engineering and technical assistance for global military communications satellite systems (undisclosed amount).

### INDUSTRY

$1,700,000—**F. J. Stokes Corp.,** Santa Monica, Calif., from **Douglas Aircraft Corp.,** for construction of three space-simulator chambers.

$1,500,000—**Beckman Industries, Inc.,** Richmond, Calif., from **Boeing Co.,** for three analog computer systems to be used in the design of the *X-20 Dyna-Soar*.

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

Hawk Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

Machining, potting and testing of Hawk EPU fuel sticks. Ordnance part No. 9175608—1624 each with options for quantities of 202 and 162 each. Deliveries to Red River Army Depot. Duplication of initial investment, special tooling and facilities and nonavailability of adequate drawings and specifications preclude award to other than the prime contractor, Raytheon Co., Willow Street, Waltham, Mass. All inquiries relative to subcontracting are referred to Raytheon Co. at the above address.

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Hercules Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

The Army Missile Command proposes to procure from Surprenant Manufacturing Co., Boston 10, Mass., the 75 conductor cable assembly. This synopsis is to publicize subcontracting opportunities. All inquiries relative to subcontracting must be referred to Surprenant Manufacturing Co. at the above address. Do not contact the U. S. Army Missile Command with respect to this procurement.

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U. S. Army Missile Command
Redstone Arsenal, Ala.
Att: AMCPM—SEPM

*Sergeant* shop set, ground support, semi-trailer mounted, 5 each—*Sergeant* shop set, ground support, unmounted—4 each. Destinations to be furnished. Available specifications, plans or drawings relating to this procurement do not fully provide all necessary manufacturing and construction details. Request for proposal has been issued to Sperry Rand Corp., Sperry Utah Company Div., 322 No. 21st St. West, Salt Lake City 16, Utah. Small business firms or others interested in subcontracting opportunities in connection with this procurement should make direct contact with that firm.

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General Support Div.
Directorate of Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

Contract field technician services to be performed by personnel specifically trained and qualified to advise and assist in the assembly, installation, adjustment, operation and maintenance of *Redstone* missile system equipment and components. Request for proposal has been issued to Chrysler Corp., 341 Mass. Arsenal, Detroit 31, Mich. Firms interested in subcontracting opportunities should contact Chrysler Corp. at the above address.

Purchasing Office
Range Procurement Div. (MTDRC-4)
Air Force Missile Test Center
Patrick Air Force Base, Fla.

Telemetry prediction receiver/recorder group, 19 each—radio frequency distribution subsystem, 12 each—radio frequency calibration subsystem, 2 each—remote signal recorder subsystem, 1 each—telemetry tape copy subsystem, 1 each—parts list, spare parts, instruction books and other support items. Deliveries to Patrick AFB, Fla. This procurement will be accomplished in two phases: (1) Submission and evaluation of technical proposals without pricing to determine acceptability of supplies and services offered. (2) After evaluation of technical proposals, invitations for bids will be issued only to those firms having technically acceptable proposals. Letter request for technical proposals No. 63-1077. Due date for technical proposals 10-15-62. Complete data not available. Available specs, drawings or plans relating to the procurement described above do not fully provide all necessary manufacturing and construction details.

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U.S. Navy Ordnance Supply Office
Mechanicsburg, Pa.

Item 1, warhead, 5" rocket empty, MK 24 Mod. O, in accordance with various BuOrd drawings FSN 1340-787-0431, 50,000 each. Item 2, rocket head, 5" practice assembly, MK 24 Mod O, in accordance with various BuOrd drawings, FSN 1340-787-0430, 3500 each—Deliveries to NWS Yorktown, Va. and NAD Hawthorne, Nev. IFB 195-122-63(K)B. Bid opening 10-15-62.

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Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

Negotiations will be conducted with Thompson Ramo Wooldridge, Inc. Tapco Group, 23555 Euclid Ave., Cleveland, Ohio, for procurement of continuation work on the dynamic Rankine cycle space experiment. RFP-ASD-143348-RKNB—Note: For information only. RFP not available.

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Bureau of Naval Weapons
Washington, D.C.

This Bureau contemplates award of a contract to Aerojet-General Corp., Azusa, Calif., to provide services and materials necessary to perform normal atmospheric environmental tests on Model T-38 tracker, an experimental infrared seeker. Award will be made on the basis of a continuation of an R&D program already undertaken by this firm under an existing contract. This notice is for information purposes only. Other proposals can not be considered for this procurement. CN 1126-62 BuWeps Synopsis No. 56-63.

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Bureau of Naval Weapons
Washington, D.C.

This bureau contemplates award of a contract to General Dynamics Corp., Ordnance Aerophysics Laboratory, Dangerfield, Tex., to conduct tests on *Talos* and *Typhon* engines, perform *Talos* quality assurance environmental testing and conduct *Polaris* missile system tests. Award will be made on the basis of a program already undertaken by this firm under an existing contract. This notice is given for information purposes only. Other proposals cannot be considered for this procurement. CN 1174-64 BuWeps Synopsis No. 57-63.

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U.S. Army Engineer District, Mobile
P.O. Box 1169
Mobile, Ala.

Deflector and aspirator for *Saturn* static test tower, Marshall Space Flight Center, Huntsville, Ala.—Item—IFB ENG (NASA) 01-076-63-4B—Specs and half size drawings available at $3 per set and requests should be submitted to reach this office before 10-14-62. Approximate value of proposed construction is $1,500,000. Bid opening 10-16-62.

# names in the news


SODERQUIST


WHEELER


SHARROCK


MUELLER


BRIGGS

**James W. Dunham:** Appointed director of advanced missile systems at Norair Div. of Northrop Corp., Beverly Hills, Calif.

**David B. Chase:** Elected chairman of the executive committee of the Lionel Corp., New York City. **George E. Sokolsky** named vice chairman of the executive committee. **Earl T. Smith** named member of the finance committee and **William R. Simpson** appointed president of Dale Electronics, Inc., a Lionel subsidiary.

**Ivar C. Peterson:** Formerly with Lear Inc., joined the Beryllium Corp., Reading, Pa., as special assistant to the executive vice president.

**Fred F. Norman:** Named vice president and financial officer of Vactite, Inc., San Carlos, Calif.

**John K. O'Sullivan:** Appointed quality control manager of Montronics, Inc., Bozeman, Mont.

**Dr. J. M. B. Kellogg:** Named a research advisor at the Los Alamos Scientific Laboratory, New Mexico. **Dr. Richard F. Taschek** named head of the Laboratory's physics division and **Dr. Louis Rosen** named alternate physics division leader.

**Douglas H. Bean:** Named manufacturing manager for the systems division of LFE Electronics, Boston, Mass.

**John Stack:** Presently with Republic Aviation Corp., Farmingdale, N. Y., announced as winner of the Wright Brothers Memorial Trophy.

**Howard M. Margowsky:** Appointed president of Remanco, Inc., Santa Monica, Calif.

**Fred T. Sonne:** Appointed chairman of the board of Chicago Aerial Industries, Barrington, Ill.

**Carl W. Burrows, Jr.:** Appointed vice president, Contracts and Service Div., Simmonds Precision Products, Inc., Tarrytown, N.Y.

**Dr. Miguel A. Xavier:** Named vice president and general manager of Century Electronics & Instruments, Inc., Tulsa, Okla.

**C. W. Lindrose:** Appointed manager of Electro-Mechanical Products Section, Industrial Battery Div., Gould-National Batteries, Inc., St. Paul, Minn.

**Seymour B. Sternbach:** Appointed contract administrator of Tenney Engineering, Inc., Union, N.J.

**Dr. Shailer L. Bass:** Elected president and chief executive officer of Dow Corning Corp., Midland, Mich. **John L. Hanigan** elected to the board and named executive vice president.

**George W. Soderquist:** Appointed program manager on the program planning staff at Motorola, Inc.'s Military Electronics Div./Western Center, Phoenix, Ariz.

**Patrick N. McDuffie:** Named manager of Ford Motor Co.'s Aeronutronic Div., Southeastern Regional Office, Huntsville, Ala.

**William Lawrence:** Elected executive vice president of Laboratory for Electronics, Inc., Boston, Mass.

**D. J. Arnold:** Appointed product manager of the pump and controls group of Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio.

**Harold A. Wheeler:** Vice president and director of Hazeltine Corp., Little Neck, N.Y., appointed by the Secretary of Defense to the Defense Science Board.

**Walter J. Sharrock:** Named head of quality control for the Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio.

**John J. Dineen:** Appointed chief of advanced design, Stratos Div. of Fairchild Stratos Corp., Bay Shore, N.Y.

**David H. Dawson:** Vice president, director and member of the executive committee of E. I. du Pont de Nemours & Co., Inc., elected chairman of the board of directors of the Manufacturing Chemists' Association.

**Raymond R. Chartraw:** Promoted to manager of the field engineering department of Lord Manufacturing Co., Erie, Pa.

**Thomas H. Pretorius:** Appointed manager of Northrop Corp.'s Space Laboratories office, Hawthorne, Calif.

**Robert G. Sevrance:** Elected secretary and treasurer of the Bunting Brass and Bronze Co., Toledo, Ohio.

**Frank A. Schute:** Appointed director of sales and requirements for the Martin Co.'s Electronic Systems & Products Div., Baltimore, Md.

**John L'Hommedieu:** Promoted to manager, purchasing section, at Adler Electronics, Inc., New Rochelle, N.Y.

**Dr. George E. Mueller:** Appointed vice president for research at Thompson Ramo Wooldridge, Inc.'s Space Technology Laboratories, Inc., Redondo Beach, Calif.

**Phillip L. Gundy:** Former vice president of Ampex Corp., joined Technical Systems, Inc., Los Angeles, Calif., as executive vice president and director.

**C. C. Noah:** Appointed acting president of Astropower, Inc., Costa Mesa, Calif.

**Charles A. Heim:** Appointed assistant to the president at Autonetics Div. of North American Aviation, Inc., Downey, Calif.

**Rod L. Borum:** Named manager of Atlantic Missile Range Operations for General Electric Co.'s Defense Systems Dept.

**Frank J. Martin:** Appointed sales manager for research and development programs at AC Spark Plug Div. of General Motors, Milwaukee, Wis.

**William B. Briggs:** Appointed planning manager for the Astronautics Div. of Ling-Temco-Vought's Chance Vought Corp., Dallas, Tex.

**Dr. Lawrence Gould:** Appointed executive vice president and general manager of Microwave Associates, Inc., Burlington, Mass.

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## ——when and where——

**National Communications Symposium, Institute of Radio Engineers,** Hotel Utica, Utica, N.Y. Oct. 1-3.

**Third Symposium on Advanced Propulsion Concepts, sponsored by General Electric and AFOSR,** Sheraton Gibson Hotel, Cincinnati, Ohio, Oct. 2-4.

**National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers,** Fontainebleau Hotel, Miami Beach, Fla., Oct. 2-4.

**Tenth Annual Human Engineering Institute, sponsored by Dunlop & Associates,** Stamford, Conn., Oct. 2-5.

**Eighteenth Annual National Electronics Conference and Exhibition, sponsored by AIE, IRE, Illinois Institute of Technology, Northwestern University and University of Illinois,** McCormick Place, Chicago, Ill., Oct. 8-10.

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5. The average number of copies of each issue of this publication sold or distributed through the mails or otherwise to paid subscribers during the 12 months preceding the date shown above was: 36,834.

JAMES W. CLAAR
(Signature of publisher)

Sworn to and subscribed before me this 21st day of September, 1962.

ABE FRYBUSH
(Notary Public)
(My commission expires July 31, 1963)



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# A New Look at Meetings

AIR FORCE ASSN., the Air Force and the industry are to be commended for the sincere effort to keep this year's annual AFA meeting more business-like despite the unique distractions of the Las Vegas fleshpots. The best was made of a poor choice of locale.

Technical sessions were better attended and the atmosphere of the meeting was improved over AFA meetings of recent years.

In line with industry policy, there were fewer elaborate exhibits. This trend can be expected to continue, as it should. The AFA exhibition always has been a mere sideshow attraction of the meeting, albeit a profitable one for AFA.

It was evident that both the Air Force and the association itself were making a serious attempt to avoid the excesses that led to widespread criticism of past meetings.

The effort was not completely successful—nor could complete success be expected in just one year. But the elaborate and expensive industry parties of last year's Philadelphia meeting largely were conspicuous only by their absence.

"Booze and bashes were at a minimum by Las Vegas standards," comments one observer.

We were highly critical of AFA and its leaders following the Philadelphia meeting last year. We want to be equally quick to compliment them for an effort to put their house in order. Despite comment to the contrary by some self-centered members of AFA management, we favor a strong and useful association. It was, and will continue to be, the excesses harmful to the association which we find distasteful. AFA management should have acted to curb these before the need arose for outside criticism and industry pressure.

Rowdy meetings and the implied threat of service disfavor in the selling of magazine advertising or exhibition space are harmful to any service organization and do a disservice to the industry.

We welcome the advent of a new look at AFA. Next year's meeting, and association activities in the interim, will be the test of whether a hard lesson has been learned.

Of particular interest at Las Vegas was the adoption at the technical sessions of a technique unusual to AFA. Papers to be delivered at the seminars were submitted in advance so those attending could study them before the session. Abstracts of the papers then were read to the audience by the moderator.

With the benefit of advance reading of the papers, members of the audience were able to submit considered questions to the panel of authors and experts.

"It is true that people who came in just to get out of the heat were never able to get the drift of the discussions but those people don't matter, anyway," comments MISSILES AND ROCKETS Associate Editor Russell Hawkes, who covered the meeting. "An enormous amount of ground was covered by the people most able to profit by it."

It is a technique which should find wider use.

THROUGHOUT THE industry, we are pleased to note, thought and effort is being put into improvement of the value of technical meetings. Much of the vast amount of money which the missile/space industry is induced to pour into exhibits is wasted. Aerospace Industries Assn. is making a definite effort to cut back the millions of dollars poured down this drain. Concentration of effort and money where it will do the most good is the creditable objective of the AIA campaign.

In this connection, the American Rocket Society's effort to increase the utility of exhibits at its annual meeting, scheduled next month in Los Angeles, is worthy of comment.

ARS is organizing what it terms "technical lecture-demonstrations" in the booths. The society is encouraging exhibitors to schedule floor lectures which make use of the operating models, animated panels or other devices in the display to explain complex concepts, techniques and operational details. United Technology Corp., for example, is planning a presentation by Dr. Douglas Ordahl, manager of its propellant development branch, on hybrid rocket motor concepts. Mr. Paul Glaser, assistant program director in the *OGO* program office of Space Technology Laboratories, will discuss advanced satellite technology.

ARS will publish a schedule of these informal lectures. This approach should draw the maximum value from technical exhibits.

"As far as we are concerned, if a company simply wants to put up its banner and have a blackboard and some working models devoted to the explanation of important new concepts, we're satisfied," says an ARS national official. "Lavish displays only make display builders rich. ARS gets the same rental per square foot regardless of what the contents of the display are."

We think the idea is excellent. If it gains acceptance, company exhibits composed solely of a blackboard and a small working model may yet ease the strain on industry finances.

The same ARS official comments, in regard to last year's show in New York, which included many excellent exhibits: "We agree that there were some very flamboyant and poor exhibits."

This frank acknowledgement of shortcomings and the ARS effort to improve the utility of the exhibition promises a worthwhile display in Los Angeles.

We hope the industry will encourage and support the efforts of both AFA and ARS toward less lavish meetings of real value.

**William J. Coughlin**

*Opportunities for:*

# Aerospace Vehicles Engineers

The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

## Structures

**Senior Dynamicist.** Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

**Loads Analyst.** To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

**Reliability Analyst.** To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

**Stress Analyst.** To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

**Design.** Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environment and hard vacuum, plus a background in materials is desired.

## Heat Transfer

**Space Vehicle Heat Transfer.** Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

**Aerothermodynamicist.** Experience in hypersonic real gas dynamics, heat transfer, ablation; re-entry vehicle design, detection; shock layer; wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

## Equipment Installation

**Packaging and Installation Engineer.** To perform optimum packaging and installation design for missile and or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

## Controls

**Optical Devices.** Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

**System Test.** To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

**Control System Analysis.** Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

**Circuit Design and Development.** Experience required in design and development of transistorized control system circuits, including electronic switching and modulation techniques.

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If you are a graduate E.E., M.E., A.E. or physicist with experience applicable to the above openings, please airmail your resume to:

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OCTOBER 8, 1962

# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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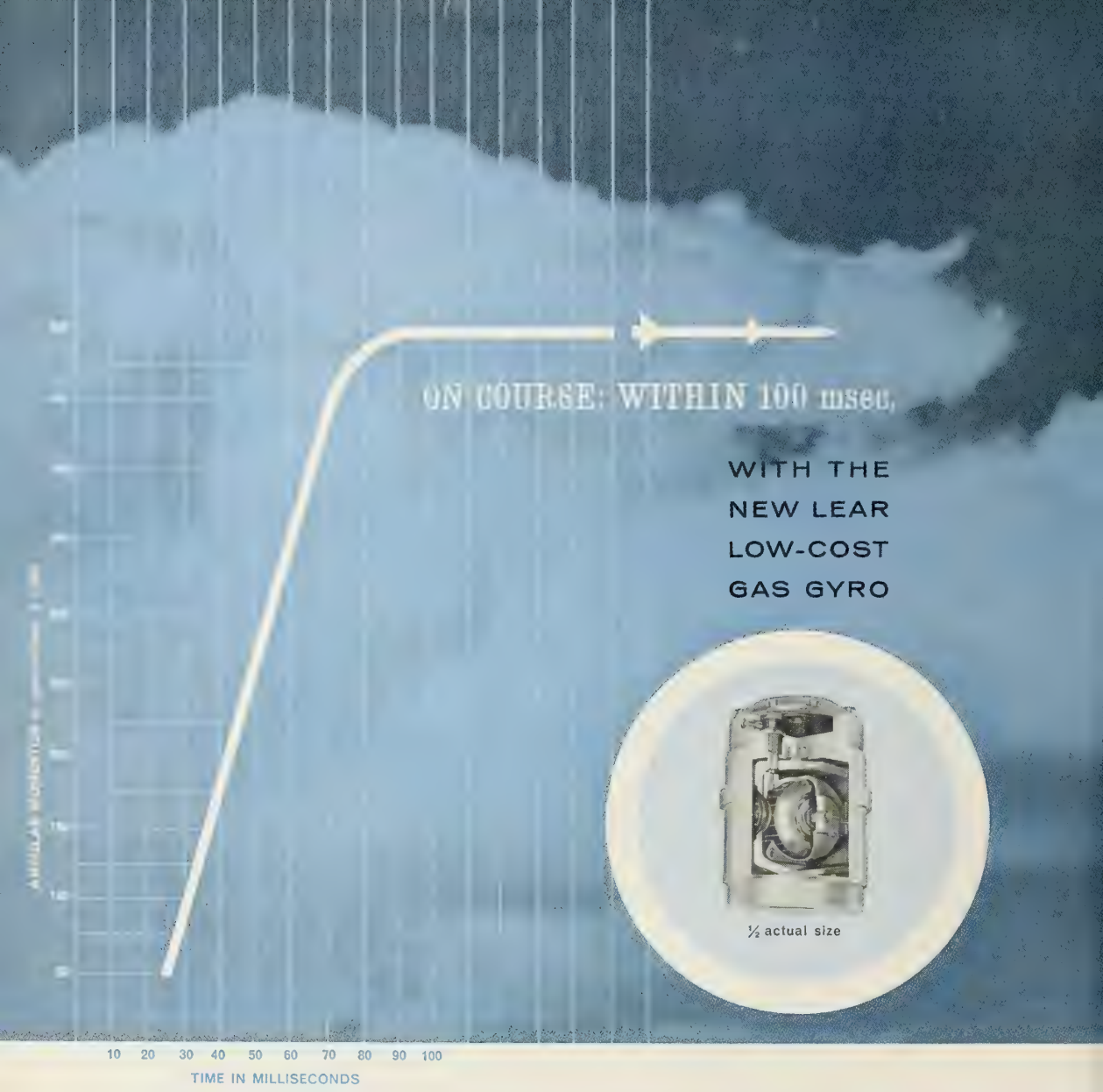



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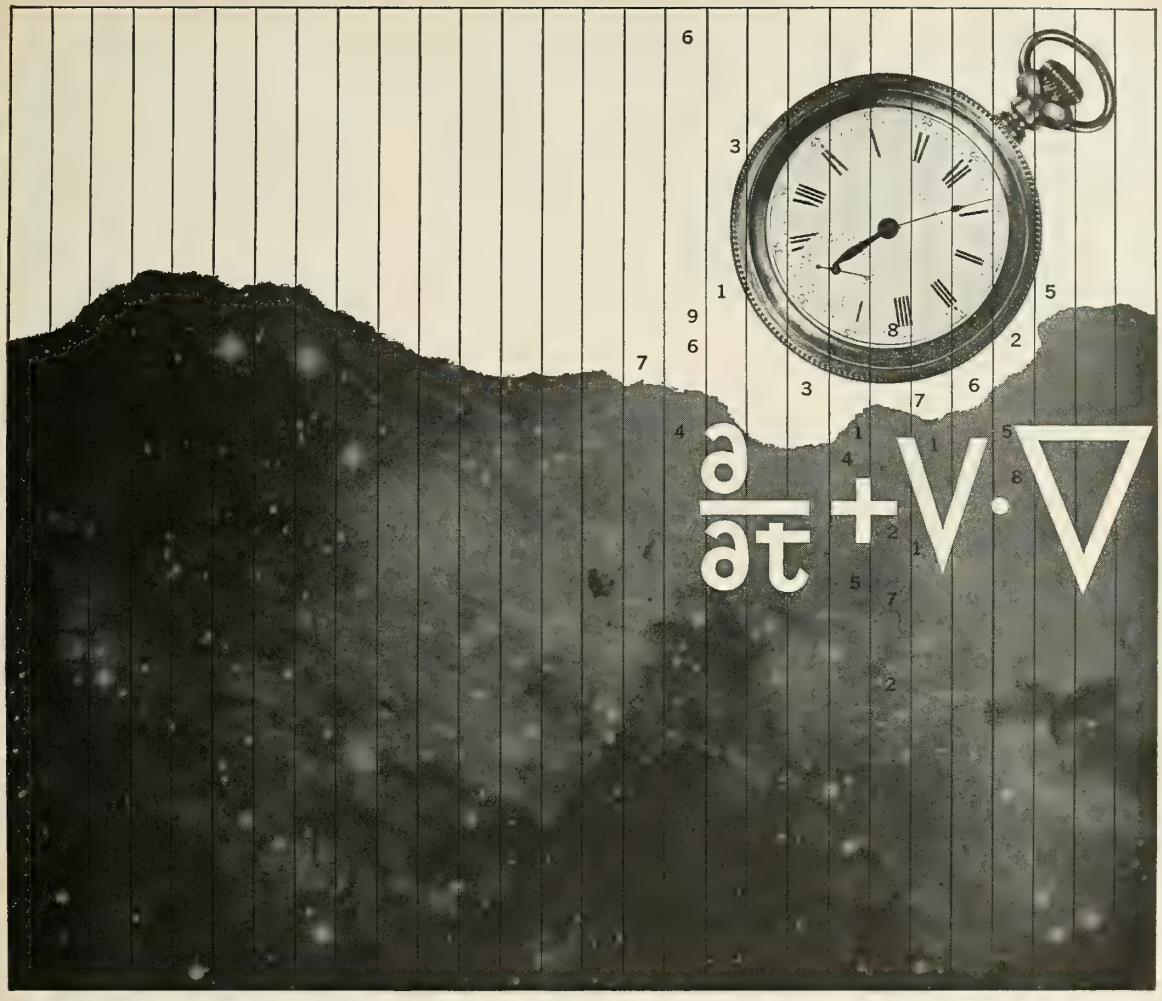
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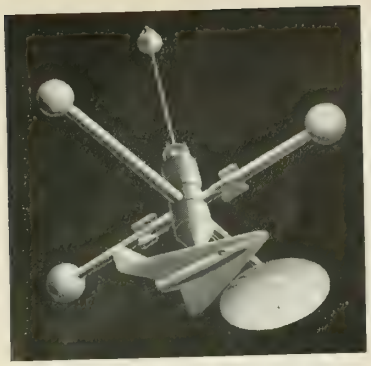
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## LOCKHEED
## Aerospace Traffic Control Center Timetable: 1970's

Will command centers based in space be an outstanding development in the ten-year span from 1967 to 1977?

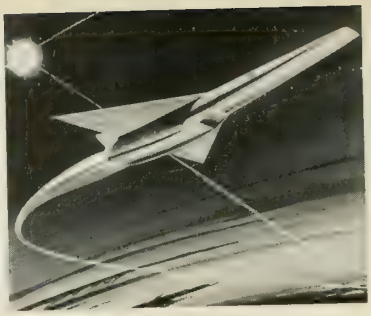
The answer at Lockheed-California Company's Spacecraft Organization is—Yes. Proof: the Spacecraft design pictured here. It reflects the maturity developed in our thinking about manned space systems.

The station—aerospace traffic control center of the 1970's—will be assembled in orbit in a series of pieces brought together by rendezvous techniques. Included: Command center; living quarters; maintenance station; radar and infrared sensing devices; nuclear power supply; communication links with the earth and other space vehicles. As now planned, 12 people will man the vehicle. Their tour of duty will be measured in weeks.

For four years Lockheed-California Spacecraft has concentrated on the needs of man in space. Activities embrace all fields pertaining to development of such complex spacecraft, as well as related supporting technologies: Space physics (radiation hazards); astrodynamics (rendezvous); biophysics (human engineering); metallurgy and manufacturing processes (materials and structures).

**Scientists and Engineers** of outstanding talent and training are needed to develop the new Spacecraft concepts of Lockheed-California in the following fields: Digital Communications; Antennas and Propagation; Advanced Systems Planning; Bioastronautics and Space Medicine; RF Equipment; Astrophysics; Astrodynamics; Communications Analysis; Aerophysics; Tracing, Telemetry, Command Engineering; Weapons Effects; Operations Research; Theoretical Physics. Write: Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1110, 2406 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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3) The Hydrofoil—whose stability, control and noise are now under intensive study by the Company.

**Scientists and Engineers** of top-level talent and training are invited to explore these immediate openings: Electronic Systems; Structural Dynamics; Flight Test Analysis; Thermodynamics; Electronics Research; Instrument and Data Systems; Systems Reliability; Propulsion; Helicopter Preliminary Design; Guidance and Control. Send résumé to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Department 1110, 2406 North Hollywood Way, Burbank, California. An equal opportunity employer.





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## This dolphin is talking...and LOCKHEED is listening!

Yes, Lockheed oceanographers and marine scientists listen to "dolphin talk." Studying acoustical characteristics of underwater creatures is part of their daily work. Unraveling the mysteries of the sea is typical of the many research projects in which they are engaged—projects that constantly create new openings, fresh opportunities. Other fields now being probed: Internal waves; low-level marine meteorology; marine geology. Moreover, for its own use, Lockheed has adapted and commissioned the deep-sea research vessel Sea Quest—one of the few such ships owned by industry.

The Sea Quest already has revealed many significant facts about sub-surface sound emission. For instance:

It has been discovered that the "sonar" system of a porpoise can sense underwater obstacles as far as a quarter mile away. Readings so obtained are added to the library of underwater animal sounds. This already includes sea lions, seals, porpoises, shrimp and many varieties of fish.

Other Lockheed scientists and engineers are busy on other projects. For example: One group is absorbed in the improvement of airborne ASW avionics. Geophysicists are concerned with the interaction of ocean, atmosphere and geography.

**Scientists and Engineers** who couple intellectual curiosity with creative ability—who like to brave the unknown and untried—will do well to investigate these opportunities: Hydrodynamics; Aerodynamics for Marine Vehicles. Write today Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1710, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 15 October 8, 1962

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Vice President.....Fred S. Hunter



## THE COVER

*Astronaut Walter Schirra became the first American to orbit the Earth more than three times when his Sigma-7 Mercury capsule successfully completed its six-orbit mission on Oct. 3. Recovery was from the Pacific.* *See p. 12.*

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# letters

## Preparing Yesterday's War

*To the Editor:*

Your editorials "The Big Knife" (M/R, Aug. 20, p. 46) and "Playing with Blocks" (M/R, Aug. 27, p. 58) were the very voice of reason.

Here, even the anti-Americans do not like the Soviet advance. In fact, I must say, Communists are delighted by the gap.

Perhaps DOD position has an explanation—for a long time French commanders were said preparing yesterday's war. Perhaps DOD caught the same disease. Perhaps they want to win the recession war . . . but they are losing your and our independence war.

J. P. Peltier
Ecole Nationale D'Ingenieurs
Arts et Metiers
Lille, France

## Anti-Merger

*To the Editor:*

As president of the National Capital Section of the American Rocket Society, I recently polled my membership to determine their reaction to the proposed merger between the ARS and the IAS. This straw vote was necessitated, I felt, by the inadequacy of information reaching the membership. Using this poll as an indication of the entire Society's attitude would be fallacious, but it is interesting to note that of a total active membership of approximately 1400:

(1) Less than 50% voted, and

(2) Of those voting, the membership was about 55% for as opposed to 45% against.

If these figures can be projected nationwide, the merger will not come into being. Our by-laws hold that 51% of the membership must vote and, of those voting, 66% must approve such a move.

As I have stated publicly, I am opposed to the merger; primarily because of the potential dilution of the aims and objectives of this society by the inclusion of foreign disciplines. As Dr. Harold Ritchey so adequately said last year in an editorial in *Astronautics*, this society is not just propulsion but it is composed of all of the disciplines necessary to effect air and space requirements. It appears, then, that we can better satisfy these requirements by supporting the American Rocket Society, a society singularly dedicated to these purposes.

Hunter C. Harrison
President
National Capital Section
ARS
Washington

## Presidential Intervention

*To the Editor:*

Your Sept. 24 editorial ("Move Over, Mr. Blough," p. 64) should be commended by every one even remotely connected with the space industry. Its provocation was harsh and your indictment was just and long overdue. When dictators with purely political motivations unjustly crack whips, simply because they wield their power, someone must cut them down to size in the interest of all. It took indignant, harassed guts to do it and I have only admiration for the deed.

If President Kennedy's dictate with U.S. Steel's price rise shocked the entire country and toppled untold billions from stock prices, his intervention in labor-management disputes is surely infinitely worse. The entire industry should stand behind Lockheed and M/R for their opposition leadership.

If Kennedy had the slightest consideration for unorganized, corporate stockholders, and the leaderless mass of consumer public in any such disputes, he would look to their interests, and not to the highly organized and vocal clamors of the trade unions for an ever and ever larger slice of the profit pie. If he is President of all our people, he should act for the good of the defenseless majority, not for a militant minority for political purposes alone.

I am not an employer and never have been, nor am I a stockholder in space industry, so the only axe I grind is that of one John Q. Public who happens to be an independent inventor of long standing. Through the years (I am 72) I have watched, ever and ever more sickeningly, the threatening buildup of union power, and the toadying of politicians to it for their own and their party's interests. When the tail begins to wag the dog, the populace should rise in ire and cut it off.

B. F. Miessner
Miami Shores, Fla.

*To the Editor:*

Regarding your editorial: Great!

If every missile/space industry firm would write as determined an article as yours—and if all the grass roots of our country as well would rise up and speak out the truth as Americans, we might yet keep our Land free.

Thanks!

E. S. Brandt
President
Brandt Advertising Company
Chicago

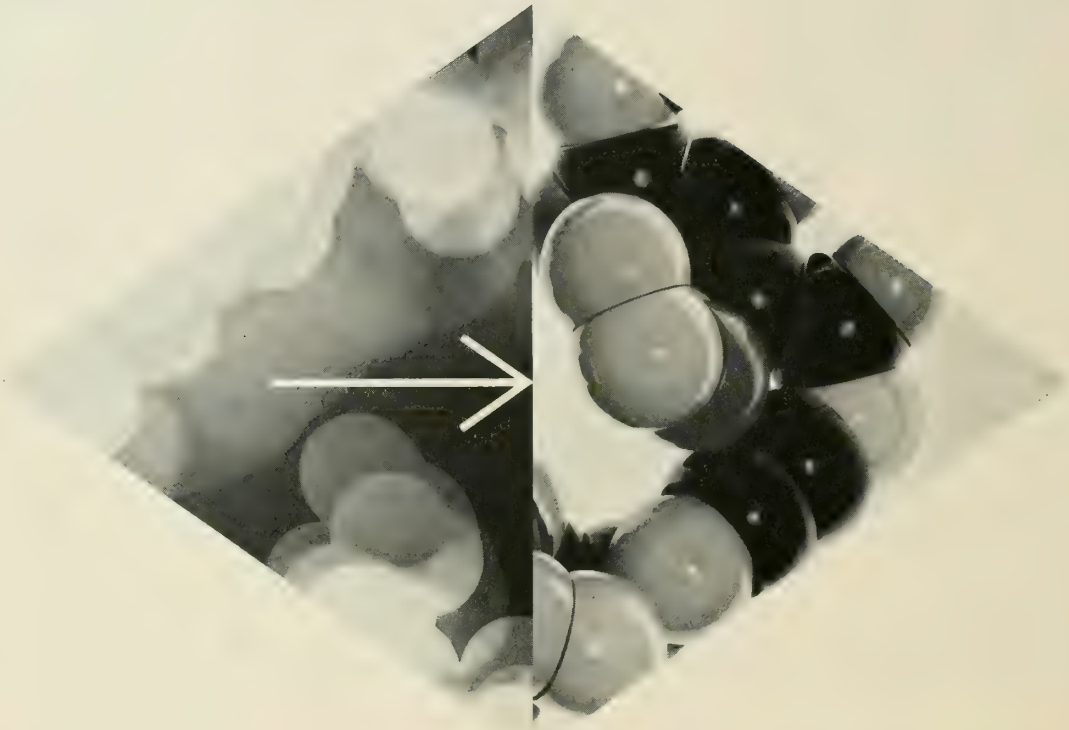
*To the Editor:*

I commend you for your courage in printing the editorial, "Move Over, Mr. Blough," in your Sept. 24 issue.

Words and deeds must be weapons used by American industry in the battle against dictatorial control. If industry does not take a firm stand and heed your alarm, the American Free Enterprise System will not survive.

H. E. G. Luyties
San Jose, Calif.

# POLYMERIZATION



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# The Countdown

## WASHINGTON

### AF May Buy Gemini Capsules

Without awaiting approval of its *Manned Orbiting Development Station,* Air Force is considering purchase of some *Gemini* capsules through NASA. Reason: to gain preliminary information on manned space flight before either *MODS* or *Dyna-Soar* is available. AF also is interested in *Gemini* as a ferry vehicle for *MODS* (M/R, Oct. 1, p. 16).

### Solids Decision Awaits Meeting

NASA Administrator James Webb and Secretary of Defense Robert McNamara still have not found time for a meeting to discuss the future of the big solids program. Despite reports to the contrary, disagreement is solely over size of the program—not who will run it. There is no need therefore to involve President Kennedy in the decision.

### Nike-Zeus Future Still in Doubt

Future of the *Nike-Zeus* antimissile missile still is in grave doubt. Advocates who hoped Gen. Maxwell Taylor, new chairman of the Joint Chiefs of Staff, would push for the system have been disappointed. Gen. Taylor feels a hard review of *Nike-Zeus* is necessary before he can make any recommendation to Defense Secretary McNamara. This presumably will come as part of the FY '64 budget review.

### Terriers Transferred to Fleet Units

More than $70 million worth of Convair *Terrier* missiles have been transferred from the Marine Corps to the Navy. The surface-to-air missile has been replaced in the Marine arsenal by the Raytheon *Hawk*.

### First Sergeant Field Test Due

First field test-firing of the Army's *Sergeant* missile is scheduled late this month at White Sands Missile Range. The solid-fueled replacement for *Corporal* will be put through a tactical exercise before firing. *Sergeant* is scheduled for deployment in early 1963.

### NASA Budget Ready for Signature

NASA's Fiscal '63 budget for $3.7 million was at the White House last week for signature by President Kennedy. It was passed by both houses of Congress in its compromise version.

### Phased Array To Be First-Orbit Tracker

Bendix phased-array radar under construction for the Air Force at Eglin AFB will be the first U.S. radar capable of providing complete orbital information on satellites on their first pass. The radar, which is 15 stories high and as long as a football field, is due for completion in 1964.

### Titan III Considered for Apollo Program

NASA officials are interested in possible use of the Martin *Titan III* launch vehicle as the booster for *Apollo* orbital test flights—replacing the *Saturn C-1*. North American Aviation has demonstrated feasibility of fairing the 12-ft.-dia. *Apollo* capsule and service module down to the 10-ft. *Titan III* core vehicle.

### Bullpup, KD2B Tested at Sea

Navy has completed shipboard suitability tests of the *Bullpup B* and *KD2B* drone target in a technical evaluation operation off San Diego, Calif. The tests included transfer by highline from an ammunition ship to the attack carrier Ticonderoga, unpacking, assembly, stowage and preparation for firing.

### Malmstrom Team in Training

A *Minuteman* missile and transport handling team, first such group to enter training, is due to finish its operational readiness course at Vandenberg AFB in time to participate in a *Minuteman* firing scheduled there this month.

### Navy Studies New Satellites

Navy space systems researchers are studying possibility of an antisatellite system for jamming Soviet satellites, according to Rear Adm. William H. Groverman, director of Navy ASW research and development. Also under study: an ocean surveillance satellite which would provide a valuable ASW assist in sorting out surface ships from submarines.

## INDUSTRY

### Apollo Over-Runs Concern NASA

Watch for drastic action by NASA to cut back on mounting *Apollo* costs. Space agency officials are much concerned by early over-runs (see p. 16).

### Solar Collector Technology Pushed

Major attention at the American Rocket Society's Space Power Systems Conference in Santa Monica, Calif., went to solar energy collector technology. Most exotic approach: an in-space fabrication method developed by Goodyear Aircraft Corp. under subcontract to Sundstrand Aviation. This 44-ft.-dia. prototype for the Air Force's ASTEC (Advanced Solar Turbo Electric Conversion) system is to be ready for orbital tests by 1965.

## INTERNATIONAL

### British Factory Is Missile Dump

Following Britain's cutback on missile programs, British Aviation Corp.'s Luton factory is being used as a dump for unwanted missile parts. Convoys of trucks loaded with nose cones, fins and ground equipment are arriving with equipment valued at some $75 million.

### Blue Streak Is Demonstrated

Britain's *Blue Streak* booster developed 275,000 lbs. thrust during a recent press demonstration. Thrust eventually is to be increased to 300,000 lbs. Both engines fired for 40 sec., with four three-in. bolts holding the vehicle down in its vertical test stand at Spadeadam, Cumberland.




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# The Missile/Space Week

## MMRBM Contractors Named

Three contractors have been selected by the Defense Department to continue program definition studies of the AF *Mobile Medium Range Ballistic Missile (MMRBM).*

Selection of the three—Aeronutronic Div. of Ford Motor Co. (in association with the Fairchild Stratos Corp.) for the re-entry system; Thiokol Rocket Operations, Tremonton, Utah, for the propulsion system; and Goodyear Aircraft Corp.'s Ariz. Div. for the transporter-launcher — left only two of the six *MMRBM* development categories to be decided.

The integration, assembly and checkout competition between Hughes Aircraft Co. and Northrop Corp. is still under consideration. Competition between Hughes and Martin Co. in association with Sylvania Electronics Products Inc. will not be decided until the *MMRBM* program enters the development phase, according to DOD.

Thiokol beat out North American's Rocketdyne Div., while Aeronutronic and Goodyear won over Sperry Rand and Avco for the re-entry system and American Machine & Foundry Co. for the transporter-launcher. General Precision, Inc., had previously been selected to develop the guidance for the missile system.

## Martin Takes Nova Award

NASA has awarded Martin Marietta Corp. the contract for a *Nova* launch facilities study.

The work will be done in two phases. In the first, ending in December and costing $85,330, the firm will develop preliminary data on launch facilities for the most promising *Nova* configuration. After the configuration has been determined late this year, Martin will undertake the second phase, calling for detailed comparison of each promising launch concept. The second phase is to cost $214,991 and conclude in May, 1963. Work will be done at Martin-Denver.

Fifteen firms bid on the contract.

## GD Bolsters Front Office

General Dynamics Corp. president Roger Lewis moved last week to strengthen his new management team with three top-level additions.

Named as vice presidents were Edward H. Heinemann, former Douglas Aircraft Co. vice president, who will have corporation-wide responsibility for engineering, and Howard L. Richardson, a former vice president of Sylvania Electric Products, who will handle GD's corporate planning.

H. S. M. Burns was named a director of the corporation. Also a director of the Ampex Corp., he was with Shell Oil Co. for 34 years before retiring as president in 1960.

## Shots of the Week

Astronaut Walter M. Schirra was successfully launched from Cape Canaveral at 8:15 a.m. EDT Oct. 3 on a planned six-orbit flight. The *Atlas* booster put its *Mercury* spacecraft into orbit with an apogee of 176 miles and a perigee of 100 miles. Period was approximately 89 minutes. (See story, p. 12)

• Canada became the third nation to orbit a satellite, when its 300-lb. *Alouette* satellite was launched Sept. 27 aboard a NASA *Thor-Agena B* from Vandenberg AFB, Calif. Designed to investigate upper levels of the ionosphere and aspects of space noise, the topside sounder satellite was put into polar orbit with an apogee of 619.2 mi., a perigee of 597 mi. and a period of 105.4 min. The launch marked several firsts for the space agency: its first launch from Vandenberg, its first use of *Thor-Agena* and first use by a satellite of extremely long (150 ft. and 75 ft.) antennas.

• *Cosmos 9*—another Soviet unmanned spacecraft to study the space environment—was successfully launched Sept. 27, Tass Soviet news agency said. The satellite has an apogee of 220 mi., a perigee of 187 mi. and an orbital period of 90 min. The equipment on *Cosmos 9* includes: a radio transmitter operating on 19.994 mcs, a radio system to measure orbital elements and a telemetric system to transmit data back to Earth.

• *Pershing* — the Army's solid-fuel replacement for *Redstone*— scored its 33rd success out of 40 flights in a Sept. 26 launch from Cape Canaveral. Though the test was monitored from the blockhouse, tactical equipment including the system programer test station was used throughout the test. The missile was erected 30 min. before launch and then fired 350 miles down the AMR.

• A *Nike-Zeus* anti-missile was successfully fired from an above-


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ground launcher at White Sands Missile Range Sept. 27. All test objectives were met, the Army said.

• Heat transfer rates at low angles of attack and at relatively low air speeds plus stability with ventral fin removed were test objectives of a Sept. 28 *X-15* flight by NASA pilot John B. McKay. The plane reached 2693 mph and 67,000 ft. Engine burn time was 127 sec.—a record for the *X-15* which was achieved by reducing thrust to 40%.

• A secret Air Force satellite was launched from Vandenberg AFB, Calif., Sept. 29. No other information was released.

• The Navy's *Q-2C Firebee* jet drone was successfully launched from the ground for the first time at Pt. Mugu, Calif., Sept. 21. The drone, which reached 45,000 ft. during its 44-min. flight, was recovered later from the Pacific Ocean.

• NASA's *S-3A* satellite was successfully launched by a *Thor-Delta* rocket Oct. 2 from Cape Canaveral (see p. 14).

• The Air Force announced last week that a *Minuteman* ICBM was launched successfully from an operational silo at Vandenberg AFB for the first time Sept. 28. AF Systems Command and contractor personnel supervised the launch, which was made by a SAC crew. A malfunction in flight forced the range safety officer to destroy the ICBM over the Pacific Range.

## Two Echo Shots Scheduled

NASA will launch two Project *Echo* balloons this month from a site near the White Sands, N. M., missile range.

The suborbital flights with a 100-ft. diameter *Echo* passive communications satellite and a 135-ft. advanced satellite are designed to measure the smoothness of the larger balloon at various internal pressures.

First launch with the smaller satellite will take place about Oct. 16; the launch with the larger balloon will follow a few days later.

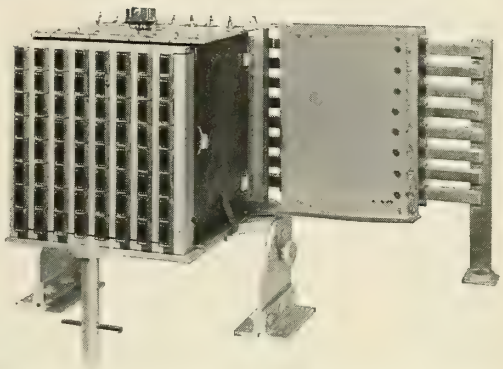
The space agency announcement said that the data are needed before an attempt can be made to put the *Echo* into orbit next year from the Pacific Missile Range.

The *Echo I* balloon is being launched as a "standard" since its reflective characteristics in orbit are well known.

During a previous test conducted July 18, the balloon appeared to inflate, but radar data indicated it was not smooth.


Opportunities in Basic Research or Development in the fields of

ELECTROMAGNETIC THEORY & ANTENNAS



■ Requirements of new and continuing projects concerned with space vehicle communications, navigation, and radar have created new openings for electromagnetic theory specialists as well as antenna engineers. The scientists and engineers of the Research and Development Division of the Hughes Aircraft Company Aerospace Group in Culver City are providing broad scientific and technical leadership to government and company funded programs on advanced airborne and space electronic systems, air to air missiles, ballistic missiles, and satellite and interplanetary communication systems. As part of this team, the Antenna Department is responsible for a diversified program of antenna research and development in the following specific areas:

1. Advanced techniques for space communication and navigation.
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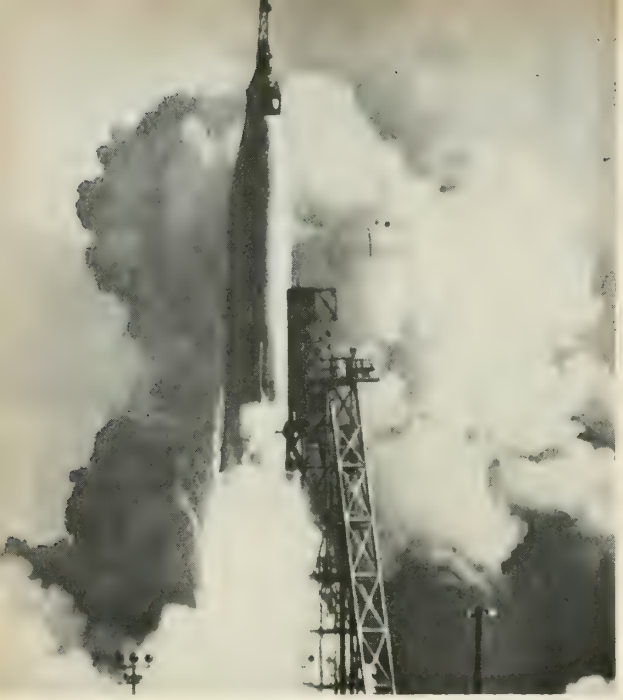
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*SCHIRRA jokes with NASA technicians prior to launch.*

***Due early next year . . .***

# One-Day Flight Plans Pushed

***NASA hails complete success of MA-8; huge fuel saving results from drifting***

**by Hal Taylor**

CAPE CANAVERAL—Success of Astronaut Walter M. Schirra's six-orbit *MA-8* mission means NASA officials will begin at once to check out a spacecraft for a one-day mission early next year.

"*Mercury* Capsule No. 20 will arrive at Cape Canaveral in one week. Checkout will begin almost immediately," William Bland, deputy project officer at the Manned Spacecraft Center, told MISSILES AND ROCKETS last week.

Step-up in the *Mercury* program was disclosed shortly after Schirra completed the long flight in his *Sigma 7* capsule.

Launched at 8:15 a.m. EDT Oct. 3, the Navy commander was successfully recovered by the carrier Kearsarge after a water landing 275 miles northeast of Midway Island in the Pacific at 5:28 p.m. EDT. Duration of the flight was 9 hours, 13 minutes.

Launched by a slightly modified *Atlas D* booster, the *Sigma 7* capsule orbited the Earth with an apogee of 176 miles and a perigee of 100 miles. The spacecraft speed was 17,560 miles per hour, and the orbital period was 88.5 minutes.

NASA hailed the flight as completely successful, declaring that it opened the way for longer-duration manned spaceflights in projects *Mercury*, *Gemini* and *Apollo*.

Officials confirmed that the next step in the U.S. manned spaceflight program will be a one-day-long flight early in 1963. Bland said the flight would be either 16, 17 or 18 orbits. Another NASA official disclosed that the 17-orbit mission is most likely.

No decision has been made, but all are possible because each permits the desired Atlantic Ocean recovery.

NASA has four one-day flights scheduled, but space agency officials report that only two will be made. These would span the period before *Gemini* flights begin early in 1964.

While NASA officially says the first one-day flight will be made early next year, Bland indicated that slippage into the second quarter is quite possible. The pilot is expected to be Air Force Captain LeRoy Cooper.

A second flight would follow late in the third quarter or early in the fourth quarter of 1963.

Bland refused to discuss experiments and pilot duties planned for the *MA-9* mission. He said that many had been proposed but no final decisions have been made. It is expected, however, that these will be designed to test pilot performance and the effects of weightlessness during the longer missions.

• **New confidence**—The extremely successful *MA-8* flight dispelled all doubts concerning the effects of weightlessness and the capability of the *Mercury* spacecraft for long-duration flights.

Especially important was the successful utilization of drifting flight for fuel conservation and Schirra's ability

to come through with no ill effects the long period in which the McDonnell spacecraft's attitude was allowed to yaw freely.

NASA disclosed that 48% of the fuel for both the automatic and manual control systems would have to be available at the end of the third orbit in order to permit a six-orbit mission.

Early in the first orbit, Schirra began the fuel conservation program by controling the spacecraft with the automatic system which uses less fuel. At 12:13 p.m. EDT the astronaut went into complete drifting flight which allowed the spacecraft to yaw freely with no control exercised by either the manual or automatic systems.

At 12:38 p.m. EDT, Schirra informed the Hawaiian Islands tracking station that he had 90% fuel remaining in both control systems. At 12:47 p.m. EDT, the Cape Canaveral *Mercury* Control Center gave the "go" decision for an attempted six-orbit mission.

*MA-8* also marked the second time that a Project *Mercury* launch was marked by a complete absence of technical holds in either the launch vehicle or spacecraft.

The *MA-7* flight of Astronaut M. Scott Carpenter was delayed for eight minutes shortly before launch, but the hold was caused by bad weather conditions.

At T-45 minutes, a 15-minute hold was called during the *MA-8* flight. This was caused by defective radar at the Canary Island tracking station.

• **Small sweat**—There was one moment of alarm early in the Schirra flight. *Mercury* control reported that it had lost telemetry contact with the body-temperature measurement system. Schirra immediately began a close monitoring of his suit and spacecraft temperature.

Preliminary data from the flight has not revealed the cause for the loss of telemetry. Schirra reported that the spacesuit temperature was warm, but not uncomfortable. He began to attempt to reduce the suit temperature through a manual control. This was so successful that at the time of the "go" decision, he reported that both spacecraft and suit temperatures were very comfortable.

During the fourth orbit, telemetry recording of the spacesuit temperature mysteriously came back on. At that time, the space agency confirmed body temperature as normal.

Another *MA-8* experiment was also completed with a fair degree of success. It called for Schirra to attempt to see a flare burning on the ground as he passed over Muchea and Woomera, Australia. Broken clouds and a light rain obscured the Woomera area, but Schirra reported he could see the flare as a block of light in the cloud system.

Schirra observed the same mysterious particles reported earlier by John Glenn, Jr., and Scott Carpenter. He indicated that he knocked on the side of the spacecraft and was able to jar some loose, just as Carpenter did in *MA-7*.

For most of the fourth and fifth orbits, the *Sigma 7* was out of voice contact with NASA's 21-station tracking network. During this time, however, telemetry communication was maintained. Schirra allowed the craft to drift in attitude during these orbits.

He also continued his exercises and camera experiments.

• **Fuel to burn**—At 3:47 p.m. EDT, the Pacific Command Ship Rose Knot gave Schirra the "go" signal for the sixth orbit. Then perhaps the most striking tribute to the flight's success occurred. Space Agency officials announced before the flight that 35% of the fuel in both automatic and manual control systems would have to be available before re-entry could be attempted.

Schirra reported as he prepared for re-entry that he still had 80% of his fuel supply. This nailed down success of the drifting maneuver and its future use in manned missions.

At 5:07 p.m. EDT, all three retrorockets fired and the re-entry attitude was declared satisfactory. In quick succession, the retro-pack was jettisoned, the periscope retracted, and the drogue and main parachutes opened.

*Sigma 7* impacted only 9000 yards from the aircraft carrier Kearsarge, prime six-orbit recovery ship. Schirra chose to remain in the capsule until taken aboard the carrier. Frogmen leaped into the water and placed a flotation collar around the capsule.

At 6:09 p.m. EDT, the spacecraft and its pilot were taken aboard the carrier. Both spacecraft and pilot were reported in very good condition. Schirra was scheduled to spend 72 hours in debriefing on the Kearsarge before returning to the U. S. ⌗

## Modified Propulsion Proves Itself

**by Chris Butler**

CAPE CANAVERAL—A modified propulsion system used for the first time on a *Mercury* flight performed perfectly on the *MA-8* launch.

Use of the Rocketdyne MA-5 engine with improved injector system and hypergolic engine start eliminated pad hold-down for the *Atlas* and assured a smoother burn for the booster and sustainer engines.

The injector modification, previously used on some *Atlas D* models, consists of a series of baffles mounted on the injector plate face.

In previous *Mercury* engines, LOX and RP-1 fuel were forced through injector plates into the combustion chamber in one-inch streams.

Pressure oscillations which built up in the combustion chamber resulted in a rough start and possible danger to the booster vehicle. Two *Atlas* military rockets were destroyed during liftoff by this condition.

The modification to *MA-8* engines consisted of adding baffles to the face of the injector plates to break streams of fuel into a mist which cross-circulated and burned smoothly.

The hypergolic engine start was accomplished by installing a cartridge of triethylaluminum in each propellant line. The material ignited spontaneously on contact with LOX.

Engineers of General Dynamics/Astronautics said the smooth start eliminated the tie-down previously used on the *Atlas* to assure engines were burning smoothly before launch. This hold-down, which eats up fuel at 1500 lbs. a second, has ranged up to 4.5 seconds in the past. The Carpenter flight hold-down was 2.2 seconds.

They added that the improved engine system conserves fuel on launch and may be used in the future to lift heavier payloads. The fuel saved on *MA-8* was used for a performance margin.

GD/A spokesmen said the modified engines with baffles are used on all *E* and *F Atlas* models and have been used on some Air Force satellite shots and on the two NASA *Mariner* launches.

Bernard Hohman, *Mercury* systems engineering director for the Aerospace Corp., said a recommendation will be made to incorporate the MA-5 engines on future *Mecury* launches.

Aerospace guidance equation also were used to slightly alter the autopilot steering program to provide a smoother flight during sustainer engine burn.

One major modification was made to the *Mercury* spacecraft when a pair of 13.5 ft. antennas were added for use by the hf radio system.

The antennas, made of extremely thin strips of beryllium copper, were deployed by automatic sequencer shortly after capsule separation. ⌗

*Long flights in view . . .*

# Schirra Conducts New Biomed Tests

***Two experiments measure effects of prolonged weightlessness; 'exercise' ruled out in MA-8***

**by Heather M. David**

CAPE CANAVERAL—Astronaut Walter Schirra conducted two new experiments in each orbit of *MA-8* to determine effects of prolonged weightlessness.

Both were checks on his ability to sense his body position in space—an important factor as periods of weightlessness will increase in coming manned space projects.

Dr. Charles Berry, *MA-8* flight surgeon and NASA's chief of aerospace medical operations, said that in one test the astronaut attempted to touch three instruments on his instrument panel with his eyes closed.

In the second experiment, the astronaut took a few seconds in each orbit to close his eyes and try to visualize his body position. In both tests, he reported his accuracy in centimeters to a tape recorder. The data are now being analyzed to see how weightlessness affected him in these experiments.

• **Closer look**—Dr. Berry also said that the astronaut was being checked carefully for symptoms of debilitation caused by the longer weightless period. Blood and urine samples are being chemically analyzed for signs of mobilization, or loss, of calcium from the bones. Some signs of this did appear after Scott Carpenter's flight, but not after John Glenn's.

Schirra's cardiovascular system and anti-G reflexes were carefully monitored for unusual effects. Loss of efficiency in his anti-G reflexes would cause fainting and atrophy of the muscles much like that caused by prolonged bed rest.

An interesting feature to medical researchers was the fact that Schirra chose not to "exercise" in flight. The other astronauts had programs of muscle flexing which would tend to counteract debilitating effects of weightlessness. Schirra elected to devote more time to control maneuvers. Thus ill effects, if any, are more likely to show up in him.

Schirra was instructed to avoid violent head movements, in case this may have caused Soviet Cosmonaut Gherman Titov's sickness. Like the other astronauts, he carried injection capsules of Tigan, a motion-sickness drug. He also carried capsules of Wyamine, a stimulant for shock, and morphine.

The suit purification system was tested before flight to demonstrate that it could clear itself if the astronaut became sick to his stomach.

• **Bioinstrumentation**—A new respiration sensor was introduced in the Schirra flight. Instead of the thermistor built into the mouthpiece of the astronaut's microphone, an impedance pneumograph was used. This involved two electrodes attached to Schirra's chest to show changes in chest volume.

The AiResearch Corp. blood-pressure sensor was again used for the flight, but for the first time was especially tailored to the astronaut.

The pressure cuff mechanism, which worked perfectly during the Glenn flight, was specially fitted to prevent artifacts or other interferences from blocking an accurate reading. During the Carpenter flight, extremely erratic and high readings were received.

AiResearch said the device now gives "better than clinical" information, since the information is translated into standardized written form and is not subject to human audio interpretation.

The blood-pressure cuff was made semiautomatic for this flight. Instead of pumping it himself, the astronaut pushed a button which automatically inflated the cuff.

## Explorer XIV In Orbit

A THOR-DELTA combination hurled the 89-lb. Explorer XIV into an unusual orbit from Cape Canaveral Oct. 2. The aluminum and glass satellite carried six experiments to study charged particles, solar phenomena and magnetic fields.

Planned orbit was to have a 53,000-mi. apogee, 185-mi. perigee and period of 31 hours. Plane of the orbit was set at 90° to the Earth-sun axis; this would put the satellite's apogee in the Earth's shadow within three months, to check a theory that the magnetic field stretches to great distances on the shadow side. ⌘

• **Radiation belt**—Five solid-state radiation dosimeters were carried in the astronaut's clothing to check the effects of the new radiation level produced by high-altitude nuclear testing.

Dr. Berry said that the radiation exposure would reach only 2% of the allowable mission dose. The flight carried Schirra through the low flux portions of the artificial belt during the fourth, fifth and sixth orbits.

Readings from the dosimeters will be added to the astronaut's record, so that a total is kept of all radiation each astronaut has received during his lifetime.

Since eyes and skin are most susceptible to radiation injury, the dosimeters were placed to show what they received. Two dosimeters were located in the helmet, two on Schirra's chest and one on the right thigh. The devices are made of lithium fluoride and coated with ethylene plastic.

Fourteen additional pounds of water were carried on *MA-8* to increase the capacity of the cooling system for the longer flight. The lithium hydroxide supply for removing $CO_2$ was increased by a little more than a pound.

• **24-hour flight**—Aerospace medical experts gathered here for *MA-8* said they were now making plans for the 24-hour mission.

Among other things, recent simulator tests showed that the most advantageous times for the astronaut to sleep probably were not the times he would be able to sleep.

For instance, Dr. Berry said, the original sleep times were programmed to coincide with the times the capsule could be put into command control. But this would mean he must go to sleep about 4½ hours after launch. Dr. Berry said he didn't believe the astronauts would be able to do this,

A close look also is being taken at the bioinstrumentation system with a forward eye to *Gemini*. Dr. Berry said that some phases could use improvement but probably no major changes will be made in *Mercury* since it would require changing the entire amplification system. ⌘

*After shift of control . . .*

# DX Priority for Centaur Imminent

***But even with acceleration flight won't come before 1964***

**by Frank G. McGuire**

NASA IS EXPECTED to recommend a DX priority—highest in the nation—for *Centaur* in an all-out effort to have the upper-stage vehicle operational by 1965.

Space agency officials also confirmed they are giving serious consideration to use of the *Titan II* booster to increase payload capability of the *Centaur* (M/R, Sept. 10, p. 13).

The new developments were disclosed as NASA announced the shift of *Centaur* program respsonsibility from the Marshall Space Flight Center to Lewis Research Center.

Vincent L. Johnson, *Centaur* Program Manager, told MISSILES AND ROCKETS that "we are giving serious consideration to a DX priority."

Rep. Joseph Karth (D-Minn.) praised the NASA moves, made partly in response to criticism of the program by his House Space Sciences Subcommittee.

"Marshall Space Flight Center can spare neither the time nor talent for *Centaur* in view of their commitment to manned space flight. We shouldn't break up the *Saturn* team for work on *Centaur,* and I think this transfer is a good move. It does not reflect on either the technical or managerial competence of MSFC."

Even with its increased emphasis on *Centaur,* NASA can hope only to stay even with the program's development schedule. Originally, the first flight of the liquid-hydrogen/liquid-oxygen upper stage was set for June of this year, with flight test completion scheduled for next year.

First a long series of technical problems, then an unsuccessful first launch on May 8 pushed the operational target date into 1964.

Now, NASA admits that, even if the program is accelerated by Lewis, only a late 1964 or early 1965 target date is possible. The stepped-up schedule will call for nine launches, with the first next March or April—an almost impossible job.

• **NASA Centaur report**—The space agency announcement said the new schedule follows a re-evaluation of the program which was ordered by the House Space Subcommittee. Not forthcoming, however, was a special report on *Centaur* which was also ordered by the subcommittee. Instead, the space agency sent only a brief preliminary report and indicated a detailed listing of the re-evaluation findings would not be available until the transfer to Lewis is completed.

In announcing what it called an acceleration of the liquid-hydrogen booster program, NASA said that it was also transferring to LRC development of the M-1 engine, slated for use in the *Nova* super-booster.

NASA said the transfers were made to permit MSFC to concentrate all its efforts on the manned lunar landing program. As a result, it retained responsibility for the 200,000-lb.-thrust J-2 engine.

The J-2 engine, also a liquid hydrogen project, will power the *Saturn C-1B* and *Advanced Saturn* launch vehicles. Both vehicles have prime roles in project *Apollo.*

• **Titan II candidate**—The move to Lewis, NASA reported, would enable detailed studies of the possible use of the *Centaur* stage with other boosters in future NASA programs.

A space agency official told M/R that the *Titan II* booster is being given primary consideration. With a 430,000-lb.-thrust first stage and a 100,000-lb.-thrust second stage, the *Titan II* would give *Centaur* a much greater payload capability than the presently used *Atlas.*

This could prove a big help later on. *Centaur's* primary missions are the *Surveyor* lunar soft-landing spacecraft, *Mariner* interplanetary flights and putting satellites into 24-hour synchronous orbits.

NASA officials estimated that *Centaur* will just about be able to lift *Surveyor,* even though the spacecraft weight has been reduced from 2500 to 2100 lbs. Any future increase in the weight of the spacecraft or launch vehicle because of technical changes will make the mission virtually impossible.

A new booster might also aid the success of the sychronous orbit missions. NASA now plans to use a *Surveyor* final-stage rocket motor for those missions; a new booster of the *Titan II's* capabilities would make that move unnecessary.

One optimistic note for *Centaur's* future was the announcement that the first successful test-firing of a flight stage was achieved by the prime contractor, General Dynamics/Astronautics. The Sept. 29 firing lasted ten seconds.

The engine contractor, Pratt and Whitney Aircraft, is responsible for developing the RL-10 for both the *Centaur* and *Saturn S-IV* stages. The engine develops an average thrust of 15,000 lbs. and has a specific impulse 30% better than the LOX/RP-1 combination at sea level. The nozzle configuration is designed for operation at altitude and is a modified bell design with an expansion ratio of about 40:2.

The engines have a multiple-start capability and use an exciter-spark igniter system.

Before the current revision, *Centaur* was slated to make five flights in 1963 and four more in 1964.

• **M-1 engine**—The M-1 engine program, also transferred to Lewis, is developing the largest liquid-hydrogen rocket engine to date. With 1.2 million lbs. of thrust, it is designed for clustering in the second stage of the *Nova* booster.

An Aerojet-General program, M-1 has been under the NASA Office of Manned Space Flight, directed by D. Brainerd Holmes. At Lewis, it will be set up as a separate office under Bruce Lundin.

• **Feasibility established**—Despite the troubles encountered, NASA Administrator James Webb said data from the May 8 *Centaur* flight supports the concept and the design as a sound basis for intensified effort. He said he is confident the acceleration will result in a vehicle capable of the high-performance missions assigned to it.

• **Management and funding**—At Lewis, *Centaur* is being placed directly under LRC's director, Dr. Abe Silverstein, and assistant director for development Bruce Lundin. A separate M-1 office under Lundin is also being set up.

Overall *Centaur* program responsibility as in the past will rest with the NASA Office of Space Sciences under Dr. Homer Newell.

Funding is expected to increase in the Fiscal 1963 budget from $67 million to about $100 million, with a similar amount anticipated in Fiscal 1964. ❖

*Geographic broadening . . .*

# DOD Seeks Procurement Diversity

***Upcoming seminars to acquaint lagging areas of country with defense contracting criteria; Midwest pinpointed***

**by James Trainor**

DEPT. OF DEFENSE officials are attempting to change the geographic distribution of procurement awards—expected to rise to $27 billion during Fiscal Year 1963—by acquainting lagging areas of the country with the criteria and prerequisites for defense contracting.

Basic goal of a series of forthcoming seminars is to widen the geographic base of purchasing. Explaining the philosophy behind the program, Deputy Secretary of Defense Roswell Gilpatric pointed out:

"We have a responsibility to bring to the attention of every part of the country the factors that go into defense procurement."

• **Stress on Midwest**—A particular target of DOD's education program is the Midwest area including Ohio, Indiana, Illinois, Michigan and Wisconsin. Although prime military contract awards in these five states during FY '62 totaled $3.1 billion—up 20% from FY '61 and 32% from FY '60—the area still has not recovered from the $6-billion-per-year loss suffered after the Korean War.

Failing to keep abreast of the increased emphasis on research and development in military procurement after Korea, the Midwest saw its share of the military market drop from 27% to 12%.

The missing element in the Midwest, according to Gilpatric, is the willingness of universities and industry to work together. And it is to point out the importance of this element that the Defense Department has inaugurated a policy of conducting seminars by high-level defense officials at the invitation of local authorities.

Gilpatric noted that a series of briefings will be given to industrial, university and city officials in Chicago on Oct. 11. Explaining defense procurement needs will be Dr. Harold Brown, Director of Defense Research and Engineering; Gen. Bernard A. Schriever, Commander, Air Force Systems Command; Finn J. Larsen, Assistant Secretary of the Army (R&D) and James H. Wakelin, Assistant Secretary of the Navy (R&D).

• **Missiles leveling off**—Procurement of missiles, particularly strategic retaliatory weapons, has leveled off in FY '62 and is now running at a steady 33⅓%. Thus, of the $18 billion spent on hardware during the past fiscal year, missiles accounted for approximately $6 billion. During the current fiscal year, missile procurement will run about $6.3 billion out of a total hardware procurement budget of $20 billion.

In aircraft procurement, the percentage is down from 31% to 28%. However, this category is expected to stay relatively stable, with the major changes coming in the blend or "mix" of aircraft. The emphasis is being shifted from long-range, strategic systems to tactical aircraft.

The third major category, Army

## NASA Concerned About Apollo Costs

TOP NASA officials are concerned by cost overruns being quoted by Project *Apollo* contractors.

As a result, D. Brainerd Holmes, the space agency's Moon boss, and Robert Gilruth, director of the Manned Space Flight Center, are taking a personal interest in negotiations between NASA and its industrial team.

A high-ranking official told MISSILES AND ROCKETS that the cost-cutting drive has affected contracts with North American Aviation, Inc., prime contractor for the *Apollo* spacecraft, and the industrial support team working with MIT on the spacecraft's guidance system.

The official said that Gilruth recently became involved in an attempt to reduce the size of North American's planned testing program for *Apollo*. The test plan called for far more work and funds than the space agency felt was necessary.

He also declared that cost estimates presented by members of the guidance system's industrial support team were "shocking." But this, he said, resulted from a disagreement over technical requirements, not overcharging.

"Negotiations are continuing," he said, and "we are beginning to make headway" in getting the firms estimated costs reduced."

• **Billion-dollar LEM?**—At the same time, the official estimated that the contract for the Lunar Excursion Module of the *Apollo* spacecraft will be worth from $500 million to $1 billion.

This will cover the 1962-65 phase of the contract which will be awarded later this month.

An attempt will be made, he said, to get the LEM prime contractor to make a fast start on selecting subcontractors. "We found in our work with North American that subsystem work is the pacing item," the official said.

The space agency hopes to have LEM subcontractors working on hardware early next year. Because of additional study which will be required, the LEM prime will not begin fabrication until later in 1963. It is hoped that a mockup showing internal arrangement will also be ready then. ⌗

**Total Military Prime Contract Awards, by Region***

| | FY 1960 | | FY 1961 | | FY 1962 | |
|---|---|---|---|---|---|---|
| | $ Millions | % of U.S. | $ Millions | % of U.S. | $ Millions | % of U.S. |
| New England | $ 2,058 | 10.1% | $ 2,334 | 10.5% | $ 2,736 | 10.8% |
| Middle Atlantic | 4,324 | 21.2 | 4,397 | 19.9 | 4,684 | 18.8 |
| East North Central | 2,371 | 11.5 | 2,606 | 11.8 | 3,168 | 12.6 |
| West North Central | 1,375 | 6.7 | 1,285 | 5.8 | 1,682 | 6.8 |
| South Atlantic | 1,994 | 10.0 | 2,345 | 10.7 | 2,594 | 10.5 |
| South Central | 1,785 | 8.8 | 1,812 | 8.2 | 1,953 | 7.7 |
| Mountain | 795 | 3.8 | 1,267 | 5.7 | 1,166 | 4.6 |
| Pacific | 5,578 | 27.3 | 5,951 | 26.9 | 6,960 | 27.8 |
| Alaska and Hawaii | 128 | 0.6 | 119 | 0.5 | 95 | 0.4 |
| TOTAL | $20,407 | 100.0% | $22,112 | 100.0% | $24,982 | 100.0% |

**Includes supply, RDT&E, services, construction and facility contracts of $10,000 or more, within the United States.*

Ordnance, is the most rapidly rising procurement area. Down from a Korea high of 50% to 12½%, Army Ordnance is coming up again and is expected to rise to 14-15% of DOD's procurement dollars during FY '63.

Ship construction and modernization is expected to remain steady at 8% —down from a World War II high of 26%.

The remaining percentage of procurement dollars will be spent for supply, services, construction and facilities.

• **Procurement going up**—In a report, "Prime Contract Awards for FY 1962 Compared by State and Region," released last week, it was revealed that military prime contract awards totaled $25 billion in Fiscal Year 1962, an increase of 22.7% over FY '60 procurement. Figures for FY '60 and '61 were $20.4 billion and $22.1 billion, respectively.

The economic impact of the expansion in defense contracts during the past two fiscal years has not yet been fully reflected in industrial production, the report said, since performance and delivery follow awards by a period of months or years.

The report covered prime contract awards of $10,000 or more during FY '62. However, the geographical and regional analysis did not take into account subcontracts awarded to other areas of the country by the prime contractor.

In analyzing the regional groupings, all of the regional areas showed increases in procurement awards from FY '60 to FY '62. The largest gain was recorded by the Mountain States with an increase of 47%, the smallest by the Middle Atlantic and South Central States with 8% and 9% respectively. Alaska and Hawaii—not included in any regional listing—declined 0.2% over the period.

Among the individual states, the largest gain was recorded by Colorado with 129%, followed by Indiana 105%, Georgia 89%, Utah 70%, Alabama 70%, Tennessee, 69%, Missouri 62%, Wisconsin 55%, North Carolina 55%, Minnesota 54%, Connecticut 45% and Pennsylvania 42%.

States which have lost procurement awards over the last three fiscal years include: Kansas down 31%, New Jersey down 17%, Texas down 12%, Maryland down 9%, Arizona down 9% and Oklahoma down 7%.

In spite of the gains recorded by some states, California continued to dominate the procurement picture throughout the whole period. The state received $5.993 billion of the FY '62 procurement dollars or 23.9% of the total. Other perennial leaders were New York, $2.669 billion (10.7%) and Massachusetts, $1.3 billion (5.2%). ⌘

## Russia Counters Israeli Deal

THE ADMINISTRATION'S decision to sell *Hawk* guided missiles to Israel appears certain to further accelerate the arms race in the Middle East.

The Soviet Union has indicated that it will expand its arms sales to Arabic countries to include more and better missiles. It has already supplied the United Arab Republic, Iraq and Syria with TU-16 jet bombers, MIG-21 fighters, and certain types of defensive missiles.

Britain announced last week that the U.S. decision has "created a new situation" which would force the U.K. government to review its past policy of not supplying either side with advanced weapons. Consideration will be given to supplying defensive missile systems "to the areas as a whole," a British spokesman said.

The decision to sell Raytheon *Hawks* to Israel was made after an Administration review of the Middle East power balance revealed that Soviet arms shipments to Arabic countries were tipping the balance in favor of the Arabs.

In a reversal of previous Administration policy, State Department officials said that they expected the negotiations with Israel to be concluded soon. The number of *Hawk* units to be bought by Israel was not revealed.

Once the negotiations are concluded it is expected that at least a year will pass before Israel receives delivery of the first *Hawk* units. During that time, Israeli technicians will be trained in this country and U.S. advisors will supervise the construction of *Hawk* missile sites in Israel.

A single *Hawk* unit—consisting of a six-launcher battery with its associated ground and guidance equipment—is expected to cost Israel $10-$15 million.

*Hawk* is a surface-to-air guided missile built by the Raytheon Co. The supersonic missile has a range of about 22 n.m. and a ceiling of from 100 ft. to 38,000 ft. Armed with a non-nuclear warhead, *Hawk* is designed for defense against low-flying aircraft, but it has successfully intercepted *Honest John, Little John* and *Corporal* missiles in tests that demonstrated its versatility. ⌘

# Proposed System Checks Satellite's First Orbit

## *Simple GE concept uses off-the-shelf hardware and straightforward computational methods*

UTICA, N.Y.—General Electric designers report that an X-band radar altimeter and a simple digital computer, coupled with standard attitude-reference and autopilot subsystems, are sufficient to determine satellite orbital characteristics during the first orbit.

Using this approach accuracies are believed possible to roughly 1.2 ft./sec. in measuring the horizontal velocity component, 50 ft. in altitude and 0.25 ft./sec. for radial velocity.

The concept has been studied over the past several years by engineers at GE's light military electronics department. Called COGS (Continuous Orbital Guidance System), it was first revealed by the company at the recent Eighth National Communications Symposium here.

Using straightforward computation methods and off-the-shelf hardware, designers claim they can build a 20-30-lb. self-contained guidance system. Low in cost and simple in design, COGS could be employed, they assert, in any Earth-orbital satellite, manned or unmanned, up to an altitude of 1200 nautical miles.

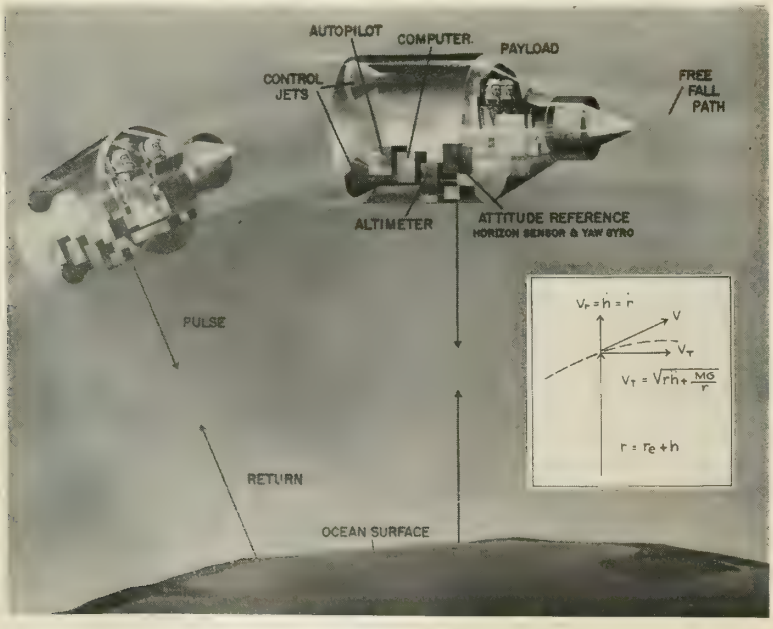
Employed in an Earth-orbiting satellite, or as shown in a *Gemini* manned vehicle, a pulse-radar altimeter makes altitude measurements continually at successive points in time. The vehicle's attitude-reference subsystem maintains the craft roughly horizontal to the surface beneath it during measurement.

By obtaining two successive altitude readings and dividing by time, the rate of change in height $\dot{h}$ or radius $\dot{r}$ can be obtained over a small portion of the Earth's surface. With additional measurements, the second derivative of altitude can be obtained.

Determination of orbital characteristics is based on the altitude measurements (see the vector diagram inset), and is represented by many sets of three orbital parameters: radial velocity $\dot{r}$, horizontal velocity ($V_T$) and the radius from the center of the central force field. $V_T$ is calculated as shown in the inset.

• **Readings over water**—Since orbital parameters depend largely on the accuracy of altitude measurement, readings are obtained while over water.

*CONTINUOUS orbital guidance system applied to Gemini-type vehicle.*




In a typical application of COGS, the vehicle coasts upward to apogee after boost phase. During this staging period, which may vary from 30 to 400 seconds, COGS can be used to assess performance of lower stages and permit readjustment to the insertion stage guidance program, designers say.

This can be a critical time, since the insertion stage may occur out of the line of sight of ground guidance control stations.

Assuming an inertially controlled insertion with typical error, GE feels COGS can be used immediately after insertion to measure performance rapidly and permit orbital path correction.

Later, and particularly in low-orbit situations, COGS can be used to effect continuous orbit restoration by detecting decay due to drag or other operational abnormalities.

Also, developers say, COGS would be extremely useful for orbital touchup on missions requiring an orbit change or change in path shape.

• **Radar requirements**—To support the COGS concept, GE performed an optimization study of radar altimeter characteristics for application to staging coast periods and on-orbit satellite operation (see table).

| **Pulsed Radar Altimeter Characteristics** | |
|---|---|
| Power transmitted | 2 kw peak |
| Center frequency | X-band |
| Transmitted pulse width | 1 μsec |
| Rise time of transmitted pulse | 0.1 μsec |
| Pulse repetition frequency | 100 cps |
| Altimeter accuracy (at 250 miles) | |
| Bias errors | ±50 ft. |
| Pulse-to-pulse errors | <20 ft. |
| Output information | Altitude: 100 times/sec.; resolution: 10 ft. |
| Input power required at 28vdc | 27 watts |
| Weight | 12 lbs. |
| Size | 4.0 x 8.6 x 12.0 in. (approx. 400 cu. in.) |

X-band radar was chosen with 2-kw transmitted power, since equipment at this power level was already available with the pulse characteristics shown. The 100-cps pulse repetition frequency was considered a compromise between a more desirable higher data rate and other problems associated with second-time echo return.

To minimize noise, only the return during the first pulse period will be tracked. A post-detection low-pass 0.5-mc bandwidth filter will help reduce the sea-return noise on the tracked pulse.

The selection of X-band as the best operating frequency was based on several major criteria associated with the operating environment, according to GE engineers. For satellite use, a small lightweight antenna is essential and a

5° beamwidth had been selected to provide a reasonable ratio of beamwidth to vehicle stability. Other principal factors included the need for an operating frequency not appreciably affected by water return and the always-present requirement to obtain the best return per transmitted watt.

A 30-db conical antenna was selected corresponding to a 5° beamwidth together with a system detection signal-to-noise ratio of 10 db. With these design characteristics and using a receiver with a 10-db noise figure, maximum operating altitude was determined to be approximately 2000 nautical miles over a smooth sea. With a safety factor added, however, maximum usable altitude is considered 1200 n. mi.

• **Digital processing**—COGS performance capability is directly related to the capacity of its associated digital computer, thus designers have devised at least two systems—one a single-point orbit calculator (SPOC) and the other an iterative orbit calculator (IOC).

With SPOC, which is the simpler approach, altitude measurements are pre-filtered for 30 seconds before h, $\dot{h}$, $\ddot{h}$ estimates are obtained. These are fed into the computer and are used with pre-programed equations and nominal earth-shape corrections to obtain the orbital elements of horizontal and radial velocity and radius from the Earth's center. Horizontal velocity can be determined to an accuracy of less than 5 ft./sec. in 30 sec. time or to about 1 ft./sec. in one minute.

By employing slightly more complicated equations, rate of change of vehicle energy, total velocity, and velocity vector, direction can be obtained, together with necessary control-system inputs.

Although considerably more complex, the IOC computer could provide a $V_T$ reading to less than 1.2 ft./sec. in 32 sec. IOC is a feedback system capable of producing elliptical parameters directly. It would also be better suited to performing control computations, designers claim.

The 16-lb., 0.35-cu.ft system would require about 10 watts power, would have a program core memory of 512 words (14 bits each) and a working-core storage of 256 words (32 bits each).

To further extend COGS capability, GE designers have developed a method to obtain orbit-plane inclination using a single ground-based transponder. The unit must be at a known location and must be able to identify itself.

The method of solution by the spacecraft essentially involves the use of three velocities: local earth-rate velocity of the ground station; satellite horizontal velocity; and relative velocity between satellite and ground station. ⌘





# Two new CEC Piezoelectric Accelerometers *

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Engineering degree, familiar with systems analysis and integration, and capable of design reviews and parts application reviews. Should be aware of the relationship in the aerospace field between reliability and such factors as design, manufacturing, quality control and assurance, packing, shipping, storage, maintenance, checkout, etc.

**ROCKET PRELIMINARY DESIGN**

To conduct analytical and design studies and investigations in all areas of rocket engines and rocket systems, including conceptual design and support analysis for new rocket propulsion systems. Requires BS or advanced degree in ME, AE, ChE or Applied Physics with minimum 6 years experience in thermodynamics and fluid dynamics, or heat transfer as applied to liquid propellant rocket engines.

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BS in AE and 2 to 6 years experience, with thorough background in analysis work in one of the following areas: heat transfer, propulsion system performance, flight mechanics, dynamic stability and handling qualities, static aerodynamic characteristics.

**STRUCTURES ENGINEERING**

To develop structural concepts for high temperature and space structures, establish and direct test programs, prepare research proposals. BS with 8 years in stress analysis and structural design, including high temperature structures and associated thermal materials.

**HUMAN FACTORS ENGINEERING**

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**AEROSPACE PRELIMINARY DESIGN**

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# Technical Countdown

## ELECTRONICS

### Telstar Holding Up Well

Output of the *Telstar* solar cells has been reduced to about 85% of initial power, says Bell Telephone Laboratories' latest report on the satellite's condition. Its output will be reduced to about 68% by the end of two years. Both values are well within the expected limits of panel degradation. Peak electron flux reported is approximately $10^9/cm^2$ sec., with energies above 200 kev at altitudes from 1200-3500 miles. One-third of the electrons have energies above 1 mev, but the major damage to solar cells is from protons with energies above 15 mev. Peak proton fluxes at apogee for particles between 22 and 32 mev are about $2x10^4/cm^2$ sec., says BTL.

### New Use for Old Device

A unique fine-wire calorimeter, consisting of roughly 1000 ft. of fine insulated copper wire randomly stuffed into an opaque glass container and electrically connected into a bridge circuit, is being used by Westinghouse scientists to measure pulsed-laser output energy. When the coherent light beam is fired into the device, the wire resistance is altered by the increased temperature. The change is picked up on a galvanometer in the bridge circuit.

### Proton-proof Cells Developed

Photovoltaic power cells capable of surviving high-energy electron and proton bombardment from three to five times as long as cells now in use have been developed and tested by Electro-Optical Systems, Inc., under a NASA feasibility study contract. Key to the radiation-resistance increase is use of a controlled amount of charged impurities in the base layer. A panel of the cells will be flight-tested on a NASA space vehicle before the end of the year.

### New A-weapon Programer Tested

A solid-state fuzing and arming programer, developed by Tempo Instrument Inc. for the Army's Picatinny Arsenal was successfully test-fired recently at Yuma, Ariz. The device reportedly performed within the required accuracy specification of 0.1%, indicating considerable control in sequential arming and detonation of tactical atomic warheads. The unit is designed to operate over a $-65°$ to 165°F temperature range, at shock and acceleration levels of 100 G's, and under vibration of 5 G's at 2000 cps.

### RACEP Manpack Unveiled

A miniaturized 4½-lb. version of the Martin Company's RACEP (Random Access and Correlation for Extended Performance) communications system will be shown at the annual Association of the U.S. Army convention in Washington this week. Designed for initial use by ground troops, the transceiver operates as a fully duplexed pulse-modulated wideband system and is capable of transmitting voice or data up to 2 miles. Also, the system provides telephone-type direct dialing without the need for wires or a switching central.

### NASA Gets New Spacecraft Test System

Epsco, Inc., has delivered a new data-collection and analysis system to NASA's Goddard Space Flight Center. It will be used for pre-launch checkout of various space vehicles with up to 2000 test points, the company says. Data conditioning modules will be placed at each test area and resulting test data will be directed to a central ADP complex. This, says Epsco, will permit close control of multiple tests and thus assist NASA to coordinate and centralize control over all environmental tests.

## ADVANCED MATERIALS

### Polyurethane Processed in Sheets

To be marketed under the name of Seilon UR, polyurethane is now available in sheet form instead of the more familiar foam. Developed by Seiberling Rubber Co.'s Plastics Div., the tough polymer is being produced in 52-in.-wide rolls in thicknesses of 0.005-0.060 in. Seiberling says Seilon is impervious to petroleum products, will not embrittle or crack under gamma-ray exposure, remains flexible to $-100°$F, and offers tensile strengths to 8000 psi and a modulus at 300% elongation of 1700-2200 psi.

### More Ductile Beryllium Sought

In an attempt to develop a far more ductile form of beryllium, whose metal-working properties are presently limited by brittleness, National Research Corp. is building a large-scale facility for producing submicron beryllium having a minimum oxygen content. The work is being performed under a subcontract to Nuclear Metals, Inc., for the Air Force Aeronautical Systems Division, Wright-Patterson AFB.

### Rubies Cultivated at Redstone

Sapphires and rubies for experimental lasers are being grown in a new production plasma furnace at the Army Missile Command, Redstone Arsenal. Ruby growth begins by pouring $Al_2O_3$ and $Cr_2O_3$ powders into the furnace, where temperatures reach 28,000°F. The powder vaporizes, falls past the flame and condenses into stalagmites in an asbestos cup. The process represents a departure from the more commonly used $O_2$-$H_2$ flame-fusion method, but Redstone chemists are investigating both.

## PROPULSION

### JATO Rockets to Undergo 10-year Test

The Navy's BuWeps has accepted an advanced aircraft JATO (Jet Assist Takoff) package, the Mk-25, developed by Rocketdyne Division of North American Aviation. The solid-propellant booster is capable of reliable operation throughout the temperature range of $-75°$ to 165°F. Fifty motors will undergo a 10-year storage program; five units will be withdrawn each year for test firing and comparison of ballistic data with control rounds.

# Mariner B To Test for Life on Mars

*Ingenious experiment for 1964 soft landing will attempt to trap, monitor microbes*

by William Beller

FOUR STICKY STRINGS and an ingenious system for detecting signs of microbe life comprise an experiment slated to be aboard *Mariner B* when the spacecraft soft-lands on Mars in 1964.

The results, if positive, would be the first step in determining whether life developed independently on each planet, migrated from one planet to another, or arose from a common source.

NASA scientists chose Mars for the experiment because it appears to be the planet best able to support life as it is known on Earth—at least in the elemental forms.

Suggestions of life on Mars come from spectral evidence of carbon-containing compounds in the planet's dark areas, and from seasonal changes in the body's appearance.

Mars, moreover, has a fairly moderate temperature range, from about −70°C to +25°C, an atmosphere composed mainly of nitrogen but with some carbon dioxide and perhaps traces of water vapor, and a pressure of a few centimeters of mercury.

The Air Force recently simulated a purported Martian atmosphere and demonstrated that certain forms of microscopic life could exist in it.

• **A life detector**—The device that will look for life on Mars works on the principle that living organisms as we know them give out carbon dioxide during metabolism. If this gas can be rendered radioactive, its presence and that of life can be detected by a radiation counter.

Known as a "radioisotopic biochemical probe for extraterrestial life," the instrument was developed by Resources Research Inc. of Washington, D.C., and designed by American Machine and Foundry Co. in Alexandria, Va. This month AMF is assembling Mod 3 for testing. Earlier models have already been successfully field-tested and improved.

The instrument, programer and associated electronics weigh about 1½ lbs. A soil sample is obtained by ejecting two 50-ft. lengths of silicon-impregnated string, which is subsequently loaded with a nutrient tagged with radioactive carbon ($C^{14}$). The string, dirtied by contact with the ground, is reeled back into the probe. Organisms caught and expiring $C^{14}O_2$ can be sensed by detectors, and the information telemetered to Earth.

The classical method for determining the presence of microbes is to find them visually—either in a growing culture or through the bubbles they make in a liquid nutrient. Either way, for a small number of cells—100-200—the process takes about 24 hours.

Seven years ago, Gilbert Levin (now Resources Research vice-president), working under an Atomic Energy Commission grant, conceived a radioisotope method for detecting microbes. This reduced the search time for an initial 100-200 cells to a matter of minutes. The technique is the basis of the present probe and also is beginning to be used for testing water samples and in medical research.

• **Rabbits too few**—Main reason for seeking Martian microbes instead of Martian rabbits, for example, is that the lower organisms if present would be far more plentiful—and perhaps easier to catch.

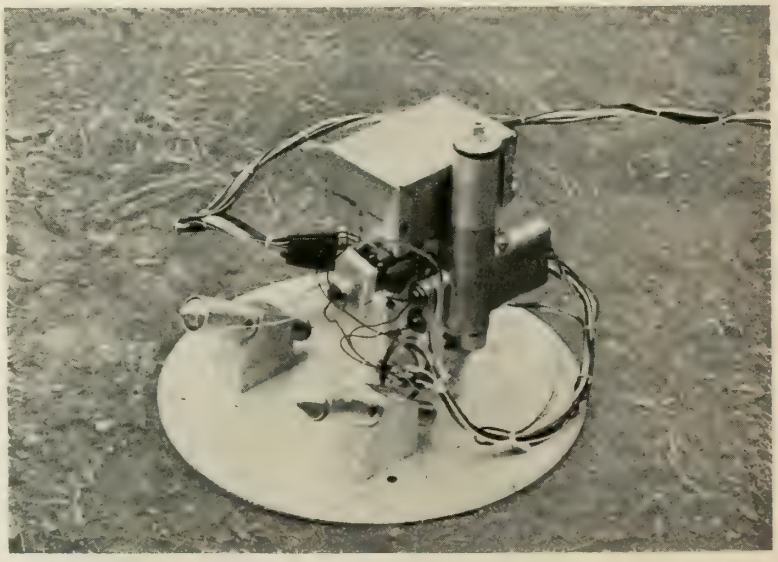
"It's conceivable to have a world with bacteria and no animals," Levin said. "But it's hard to have animals and no bacteria—if for no other reason than to decompose the animals."

He explained that for a first cut at trying to find extraterrestrial life on a planet, one must assume it takes the form of life as we know it, otherwise there is no starting point.

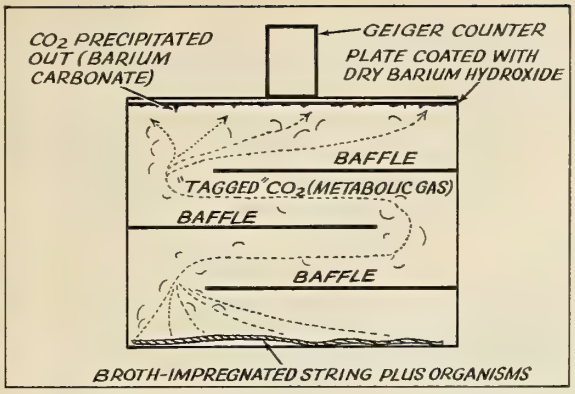
Furthermore, Levin said, on Earth elephants as well as algae operate on the same biochemical cycles as the cellular level. "Life such as this—all life as we know it on Earth—produces gases. There may be exceptions, but we have not discovered any."

"Moreover," he added, "every physiological type, Dr. Allen Heim (Research Resources senior microbiologist) tried gives off $CO_2$—and this includes photosynthetic organisms."

This is the chief reason $CO_2$ will be sought by the detector instead of some other gases commonly produced during the life process—hydrogen, hydrogen



*TEST VERSION of radioisotopic biochemical probe developed by Resources Research, Inc., for soil sampling.*




*DRAWING SHOWS generation and detection of gases.*

sulfide, ammonia and methane.

Another advantage in using $CO_2$ is that the half-life of the carbon-14 constituent is quite long—about 5500 years. Since the trip to Mars takes between 250 and 270 days, a very short-lived isotope would cause problems.

• **Detection system**—The radioisotope system is well adapted for space use. It gives out a signal easily monitored and telemetered. The system is also quite sensitive: a relatively small number of beta particles can be detected—particles about a trillion times as small as a bacterium.

The $C^{14}O_2$ of metabolism rises through a labyrinth in the instrument to a barium hydroxide-coated plate, which forms the face of the radiation detectors—in the latest model, Geiger counters. Reacting with the barium hydroxide, the carbon dioxide precipitates out as barium carbonate. At the same time, it signals its presence through beta-particle decay.

The cosmic-ray radiation flux on Mars is expected to be 10 to 50 times higher than on Earth because of the relatively thin atmospheric sheet around the red planet. This puts noise into the system. It may also give an ambiguous answer, since radiation detectors cannot tell the difference between cosmic and beta rays. To overcome this problem, two Geiger tubes mounted in anticoincidence are used.

• **The control**—Two identical units are to be included in the *Mariner B* capsule—one of them a control unit. A. Wendall Carriker, AMF project engineer, said the logic circuitry is designed to establish which of the two units has the lesser counting rate after it is emplaced on Mars, and to "kill" that one off immediately with injection of an antimetabolite. This system has the advantage of an added safety feature —eliminating the control unit if one of the two units does not work.

• **Operating on Mars**—In Mod 3 of the instrument, the nutrient ampoule is inside the spool around which the sample collection lines are wound. The wall of the spool is perforated to allow the nutrient or broth to be absorbed by the collection lines after the ampoule is shattered by a coaxially mounted ampoule breaker.

At the start of operations, two projectiles carrying the lines from each unit are fired; at the same time, the line retrieval motor is actuated to reel the lines back onto the spool. After the lines are in and the broth ampoule is broken, the spool continues to turn for a short time. This improves both distribution and prevents drippage.

The broth-impregnated string is then flushed by unlabeled $CO_2$ to cleanse it of any nonmetabolic tagged gases. The flushing gas is vented to the atmosphere through the line-retrieval ports.

After flushing, the ports are left open to permit the atmosphere within the chamber to equilibrate with that of Mars. Ports are then sealed and the baffle valve between gas collector and incubation chamber is opened.

This valve is said to serve two purposes: to prevent the gas collector from picking up nonmetabolic tagged and flushing gases; and to act as a baffle to prevent the radiation detector from monitoring beta particles coming from liquid broth in the chamber.

With the baffle valve open and the retrieval port closed, the system is sealed and ready to monitor metabolically evolved gases.

The antimetabolite liquid—needed for the control unit—is one-tenth the volume of the broth ampoule and is similarly injected into the incubation chamber. The antimetabolite ampoule is mounted coaxially with the spool. When a squib is actuated, the ampoule is broken and the travel of the driver pushes the antimetabolite and ampoule fragments into the center of the spool.

The present model has been modified so that it performs in all attitudes. It also can withstand sterilization temperatures up to 145°C for 26 hours. These temperatures preclude semiconductors, with their weight and power advantage, being used as beta detectors.

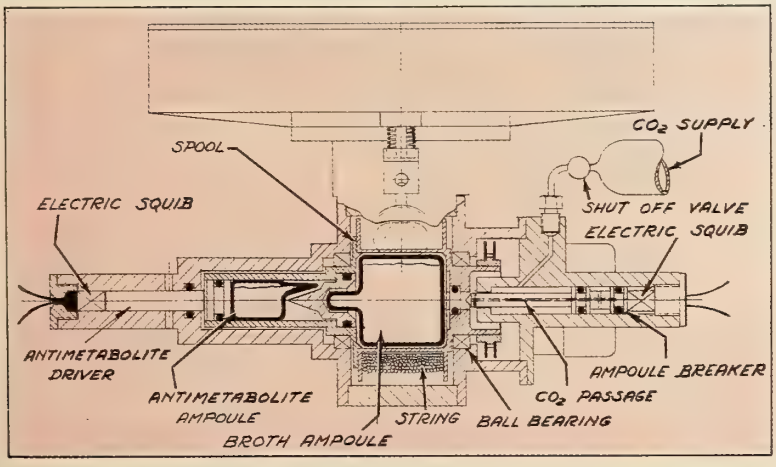
• **Life may be concentrated**—Even if the results of the experiment are negative, this would not necessarily mean Mars is lifeless. There might be areas of organic matter concentration.

These possibilities were raised by Nobel Laureate Joshua Lederberg of Stanford University, and Carl Sagan, until recently at the University of California at Berkeley, in the September *Proceedings of the National Academy of Sciences*.

The two scientists reason that if substantial amounts of moisture are frozen into the subsoil on Mars, as many astronomers have suggested, openings in the planet's crust that puff forth steam and gas—localized geothermal activity —could yield the combination of moisture and warmth necessary for life forms to survive and proliferate.

"Such hot spots," the scientists say, "should be accompanied by local outgassing and by higher water-vapor pressures in the overlying atmosphere, making these locales much more favorable microenvironments for life." ❖

*SIDE VIEW of latest probe design shows details of life-detection system.*




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NASA selects Lunar Orbit Rendezvous for first manned lunar landing.
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# NASA

*november 26* **MISSILES & ROCKETS SECOND ANNUAL NASA ISSUE**

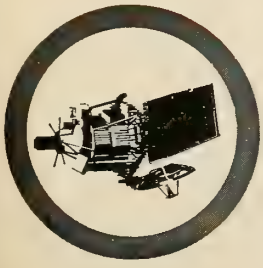
*During the months following November, the National Aeronautics and Space Administration will make final procurement and development decisions on many major programs: Aeros/Advanced Relay/Nova Super Booster/Advanced Syncom/Lunar Logistics Supply Vehicle/Lunar Exploration Module for the Apollo Spacecraft. Each program means millions of dollars to be spent in the missile/space industry.*

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# soviet affairs

By Dr. Albert Parry

### Electric Energy From the Moon

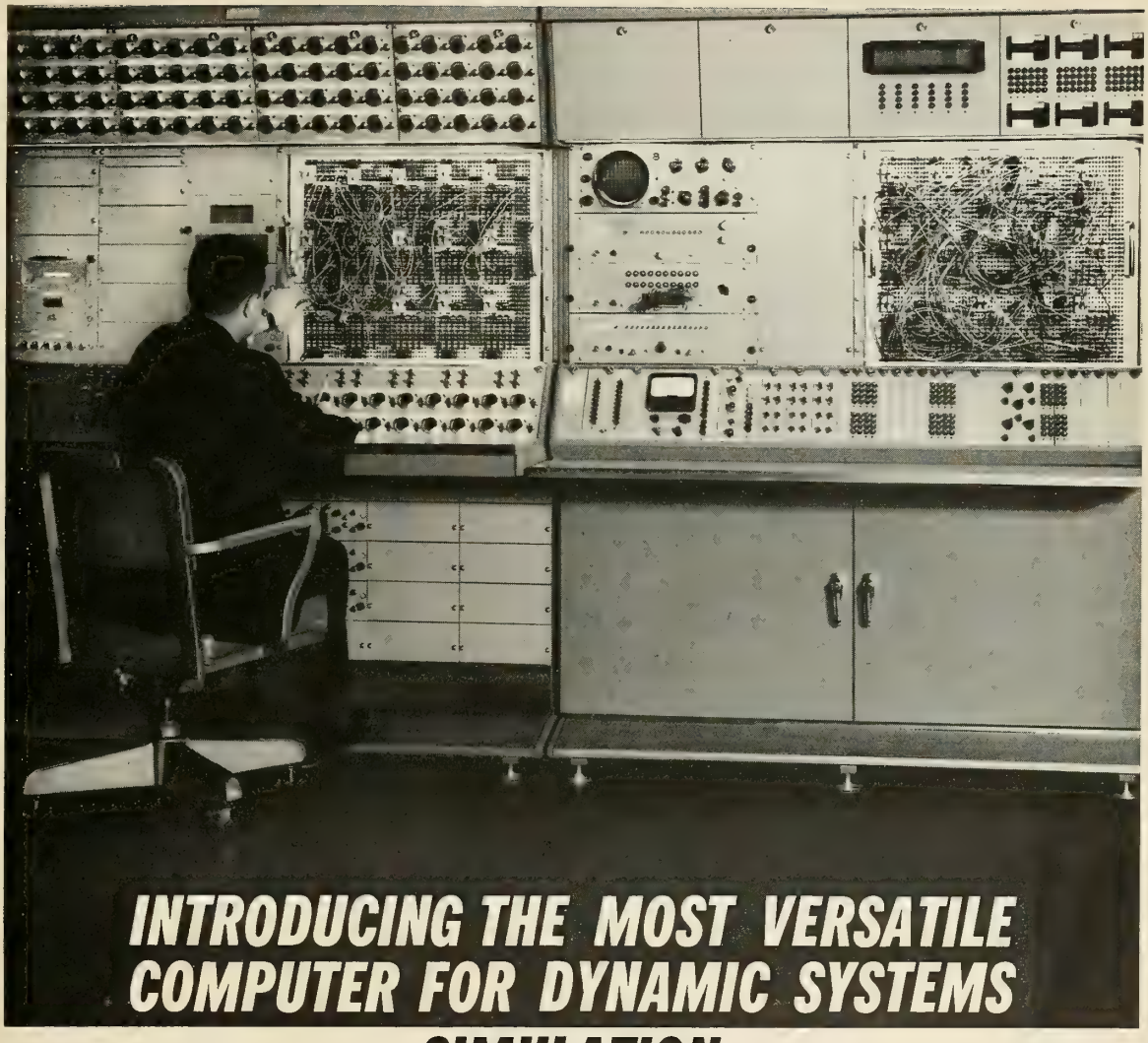
may in the future be relayed by man to the Earth, Academician Nicholas N. Semyonov, Soviet chemist and Nobel Prize winner declared in a speech delivered in Moscow at the recent International Symposium on Higher Education. "The Moon's area is 16 times smaller than that of the Earth." Semyonov said. "Due to the absence of an atmosphere, each unit of lunar surface receive three times the amount of the solar radiation received by a corresponding unit of the Earth's surface." This means that the solar energy received by the Moon "equals the energy falling upon all the continents" of the Earth. And so, "should we succeed in covering the Moon's entire surface with semiconductors-photoelements that would have a fairly large ratio of usefulness in transformation of ray energy into electric energy, and should we find methods of relaying the latter to the Earth (perhaps with the aid of guided radio-beams), then the Moon could in the future become an electric powerhouse for the Earth with a capacity of several tens of trillions of kilowatts." Professor Semyonov adds that the Earth's nuclear and hydronuclear powerhouses may in the future be transferred to the Moon, "so as to relieve the Earth from radioactive poisoning completely."

### 'Biological Rhythms and Cosmonautics'

is the title of a lengthy discussion by Yu. Fedotov, a candidate of the medical sciences, and Ye. Yudin, a physician, in *Krasnaya Zvezda,* the daily organ of the Soviet armed forces. Humans and higher animals have singular biological rhythms, regulated by their nervous systems, and varying with different times of day and night as well as with the course of the week. Changes of body temperature, blood pressure, pulse, and pace of breathing are all part and parcel of biological rhythms. Man's lowest body temperature (for instance) occurs at 3 or 4 o'clock in the morning, when humans react particularly keenly to lower temperatures outside their bodies (they shiver unduly). Physiological and psychological functions change also from day to day, slowing down toward the working week's end. The two Soviet authors write: "All these peculiarities of the biological rhythm of the human organism have a direct relation to the organization of a rational regime for cosmonauts' toil and rest." Cosmonauts Titov, Nikolayev, and Popovich were subject to the inner "clockwork" of their earthly rhythms even as they traveled in outer space where "they saw sunrise tens of times more often than we did on Earth during the same period of time." For better performance in outer space, future cosmonauts may have to submit to an artificial change of their biological rhythms. Already by now "physicians and biologists have carried out a multitude of experiments on animals to produce in them a biological rhythm different from the one they possess." Future cosmonauts may learn different rhythms quite easily; the change in rhythms, "connected with the cosmonauts' physical endurance and their high qualities of morals, morale, and willpower, will aid in man's further conquest of outer space."



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# Army's New Electronics Command Now Operational at Ft. Monmouth

*Broad reorganization expected to aid Army-industry team; budget is likely to climb close to $1 billion per year*

by Michael Getler

## Key R&D Contacts in New Command

| | |
|---|---|
| USAERDA<br>U. S. ARMY ELECTRONICS RESEARCH & DEVELOPMENT AGENCY<br>Fort Monmouth, N. J.<br>(Formerly: U. S. Army Signal Research and Development Agency)<br>Conduct continuing research in all fields of physical science leading to the development of new techniques, and the design and improvement of communications, radar, automatic data processing, combat surveillance, electronic warfare, electronic countermeasures, radiological, meteorological, photographic, drones, and other surveillance equipment, related components, and special electronic and solid state devices; and, within established national policy, equipment, materiel, and systems for communications security; perform such classified mission as may be assigned. | Industrial Liaison Engineer<br>USAERDA<br>Hexagon Building<br>Fort Monmouth, N. J.<br>Tel. 535-2240<br><br>Chief, Field Station, West Coast Office<br>USAERDA<br>Bldg. 13, 75 So. Grand Ave.<br>Pasadena 2, Calif. Tel. SY 6-7411 |
| USAERDA<br>U. S. ARMY ELECTRONICS RESEARCH & DEVELOPMENT ACTIVITY<br>White Sands, N. M.<br>(Formerly: U. S. Army Signal Missile Support Agency)<br>Conduct continuing research and development techniques, equipment, systems, and devices in the fields of missile electronic warfare, missile surveillance, environmental sciences, range instrumentation, range communications and data transmission, airborne instrumentation, and other geophysical equipment; conduct missile vulnerability investigations, studies, operations, and coordinate the guided missile electronic countermeasures effort of the Electronics Command; provide meteorological support for the research and development activities of the United States Army; conduct radio frequency compatibility investigations. | Director of Research<br>USAERDA<br>White Sands, New Mexico<br><br>Tel. White Sands Missile Range, Ext. 3110 |
| USAERDA<br>U. S. ARMY ELECTRONICS RESEARCH & DEVELOPMENT ACTIVITY<br>Fort Huachuca, Arizona<br>(Formerly: U. S. Army Electronics Proving Ground)<br>Conduct research and development of materiel as directed, to include special research in the field of micrometeorology. Provide meteorological service in support of the Army R & D programs. Exercise technical supervision and administrative control over worldwide Signal Corps Meteorological Teams. Maintain liaison with elements of the Combat Developments Command and the Test and Evaluation Command and provide data concerning activities of these organizations to the appropriate staff element of the Electronics Command. Conduct acceptability tests of materiel which require use of the special electronic, environmental, climatic or special conditions peculiar to the surrounding area. | Industrial Liaison Officer<br>USAERDA<br>Fort Huachuca, Arizona<br><br>Tel. GL 8-3311, Ext. 2326 |

FT. MONMOUTH, N. J.—The Army's new Electronics Command, born with the sweeping technical service reorganization which began early this year, has moved into operational status here.

The Electronics Command, headed by Maj. Gen. Stuart S. Hoff, former chief of R&D in the Office of the Chief Signal Officer, joins four other so-called "middle management" commodity commands previously set up by the Army and already operational—Missiles, Munitions, Weapons and Mobility. Each of the five commands reports directly to Lt. Gen. Frank S. Besson, Jr., commanding general of the newly created Army Material Command.

Electronics, headquartered here but also encompassing major facilities at Philadelphia, White Sands, N. M., and Ft. Huachuca, Ariz., and smaller offices and agencies elsewhere, will have broad responsibility for virtually the entire Army electronics effort. This includes radar, communications, electronic warfare and surveillance systems, and data processing equipment (see accompanying charts for complete breakdown of interest areas and facilities).

Funding by the new command is expected to range between $0.7 and 1 billion, according to Army estimates. The split between R&D and production monies is expected to be roughly in balance. For the current fiscal year, though firm figures are not yet available, it is estimated that funding will fall closer to the lower end of the range. In the future—barring major changes in international situations and technical breakthroughs requiring new, immediate, and heavy funding—the command is likely to experience small but steady budget gains pushing the figure closer to the $1-billion mark.

Relationship with the Office of Chief Signal Officer will be one of close liaison, according to Army officials, with the former boss of much of the Monmouth complex now serving as chief electronics advisor to the Army staff. The new command will assume all material functions previously undertaken by the Chief Signal Officer and also portions of those of the Chief of Ordnance.

With establishment of Electronics Command, responsibility for research, development, procurement, and production of Army electronics material now falls to a single command—eliminating independent control of R&D and production which existed previously.

• **Army-Industry benefits**—For the Army, and the electronics industry doing business with it, several benefits should accrue from this arrangement:

—Under the new structure, key persons responsible for the R&D phase of a project will stick with it through procurement and production phases to compeltion, insuring a smoother transition where roadblocks had been common.

## USAEMA Small Business Procurement

| | |
|---|---|
| USAEMA<br>U. S. ARMY ELECTRONICS MATERIEL AGENCY<br>Philadelphia, Pa.<br>(Formerly: U. S. Army Signal Supply Agency)<br>Supply the equipments, maintenance tools and parts required to support the electronics systems of the Army and such federal and foreign establishments as authorized; exercise worldwide centralized supply control over electronics equipment and maintenance parts; procure materiel and services required for the electronics portion of the Army Supply System; assure that electronics items delivered by contractors meet specified quality standards; plan for maintenance of a production base which will assure an adequate supply of electronics materiel in the event of mobilization. | Small Business and Labor Surplus Advisor<br>USAEMA<br>225 So. 18th Street<br>Philadelphia 3, Pa.<br>Tel. KI 6-3200, Ext. 749 |
| FORT MONMOUTH PROCUREMENT OFFICE | Small Business and Labor Surplus Advisor<br>Fort Monmouth Procurement Office, USAEMA<br>Bldg. 2525<br>Fort Monmouth, New Jersey Tel. 535-1729 |
| FORT HUACHUCA PROCUREMENT OFFICE | Small Business and Labor Surplus Advisor<br>Fort Huachuca Procurement Office, USAEMA<br>Fort Huachuca, Arizona<br>Tel. GL 8-3311, Ext 3917 |
| WESTERN REGIONAL OFFICE | Small Business and Labor Surplus Advisor<br>Western Regional Office, USAEMA<br>125 So. Grand Avenue<br>Pasadena 2, Calif. Tel. SY 6-0471, Ext. 663 |
| MIDWESTERN REGIONAL OFFICE | Small Business and Labor Surplus Advisor<br>Midwestern Regional Office, USAEMA<br>400 So. Jefferson St.<br>Chicago 7, Illinois Tel. AN 3-0234, Ext. 106 |
| WASHINGTON PROCUREMENT OFFICE | Small Business and Labor Surplus Advisor<br>Washington Procurement Office, USAEMA<br>Main Navy Building<br>Washington 25, D. C. Tel. OX 6-7802 |

—Technical personnel will be closer, in most cases, to contract offices.

—Firms with R&D contracts will deal with the same agency where a production follow-on is awarded.

—In general it's hoped that joining development and procurement responsibilities within a single, responsible commodity command will lead to easier contact and liaison with industry, uniformity in contract and procurement procedures, quicker response to industry proposals and user needs, elimination of industrial dealings with several agencies, and improvement in overall integration within technologies.

Gen. Hoff emphasizes that despite the changes within the Army structure, the procurement routes for electronics firms doing business with Ft. Monmouth or other installations will remain relatively undisturbed. The same offices and personnel (where service tours permit) will handle industry contracts. It should also be noted that firms already on the bidders' list need not re-register with the new command.

To introduce the command and its functions to industry, Army officials sponsored an industrial conference at Monmouth Oct. 2.

Though economies may arise through new management efficiency, Gen. Hoff told M/R that the goal of the move is primarily one of developing a more rapid response to the Army's electronics needs and not as much motivated by fiscal advantages.

• **Project managers used**—Key to management techniques will be the string of project managers and project officers, who with varying degrees of responsibility, will control all phases of particular projects or technical commodity developments. This technique, while new to the Army, has been successfully employed by other services.

The project managers, of whom there are already five at Monmouth, will have complete command and control over all resources delegated to the particular project. Project officers, operating within the command's product management staff, will have the same basic job but will act solely in a recommending capacity.



MAJ. GEN. STUART S. HOFF
*". . . a more rapid response to the user."*

Project managers recently assigned to the Monmouth headquarters will handle the *AN/USD-2* and *USD-5* drone programs, RADAS (Random Access Discreet Address System), CCIS-70 (Command Control Information System), and two tactical radio systems. ⌗

## Addresses of Command Field Offices

USAEMSA

U. S. ARMY ELECTRONICS MATERIEL SUPPORT AGENCY
Fort Monmouth, New Jersey
(Formerly: U. S. Army Signal Materiel Support Agency)

Provide engineering specifications for procurement of electronics equipment. Perform or monitor preproduction testing and qualification, component approval and informatory testing. Provide maintenance engineering support and establish the allocation of tools, maintenance and test equipment, and repair parts; plan and produce technical and maintenance literature for users of all electronic equipment. Administer the Contract Technical Assistance Program, worldwide.

Technical Operations Officer
USAEMSA
Bldg. T-1, Coles Area
Fort Monmouth, N. J.

Tel. 898-1423

USAADEA

U. S. ARMY AIR DEFENSE ENGINEERING AGENCY
Fort Meade, Md.
(Formerly: U. S. Army Signal Air Defense Engineering Agency)

Within the assigned responsibilities of the Electronics Command to support the Air Defense mission of the Department of the Army, provide engineering and associated services in the research, design, and development of electronic equipments, devices, and systems, to include technical coordination with user commands and interservice and Government groups to assure optimum fulfillment of operational requirements and achievement of compatibility with other related systems. Responsible in the above field for the technical and administrative management of functions incident to the fulfillment of this mission.

Commanding Officer
USAADEA
Fort Meade, Md.

Tel. OR 4-7141, Ext. 6131

USAAFO

U. S. ARMY AVIONICS FIELD OFFICE
St. Louis, Mo.
(Formerly: U. S. Army Signal Avionics Field Office)

Serve as the Electronics Command representative to the Mobility Command for resolution of logistical problems involving electronic equipment pertaining to the Army Aviation Program and the Army Surface Transport Programs. Conduct logistical evaluations of Army avionics equipment and electronic equipment applicable to Army aircraft, rail and marine items.

Commanding Officer
USAAFO
12th and Spruce Streets
St. Louis 2, Mo.

Tel. MA 1-6426, Ext. 2559

## Industry Fights GAO Charges

Lear Siegler, Inc. has responded strongly to a General Accounting Office claim of $100,300 in unnecessary costs under a negotiated contract for *Bomarc* missiles.

J. M. Walsh, president of Lear Siegler's Instruments Div., stated that though "GAO is in full possession of the facts, the information appearing in print is not in accordance with those facts."

In a report to Congress, GAO said Lear, Inc., quoted prices in a 1958 subcontract that were higher than recent cost experience warrants. Boeing Co. included the Lear prices without adequate review in its proposed initial estimate for a prime contract with the Air Force, the report charged. According to GAO, AF reviewers also failed to check the figures carefully before approving them. Lear denied this.

"As a matter of fact," Walsh noted, "by efficient programing, engineering and manufacturing methods, Lear voluntarily reduced its prices to the prime contractor," producing savings of about $1 million. Walsh estimated Lear's actual profit for the job at less than 5% before taxes . . . *In another incident, GAO clashed with Chrysler Corp., claiming the Army could have saved $5.7 million on a Chrysler Redstone and Jupiter contract. If the Army had bypassed Chrysler to deal directly with contractors, it could have saved $4.6 million on rocket engines, GAO said. The accounting office maintained that over $1 million in Chrysler administrative fees also was unnecessary. Chrysler argues that procedures used were the only way to meet accelerated schedules and were best suited to needs of the program* . . . Sources in government and industry say GAO attacks on firms for "undue" charges are part of a campaign for more efficient accounting procedures. "It is part of a move for better management," one source said, "but the contractor—especially the small subcontractor—is the one who unjustly suffers from the campaign."

## Hathaway, Continental Change Hands

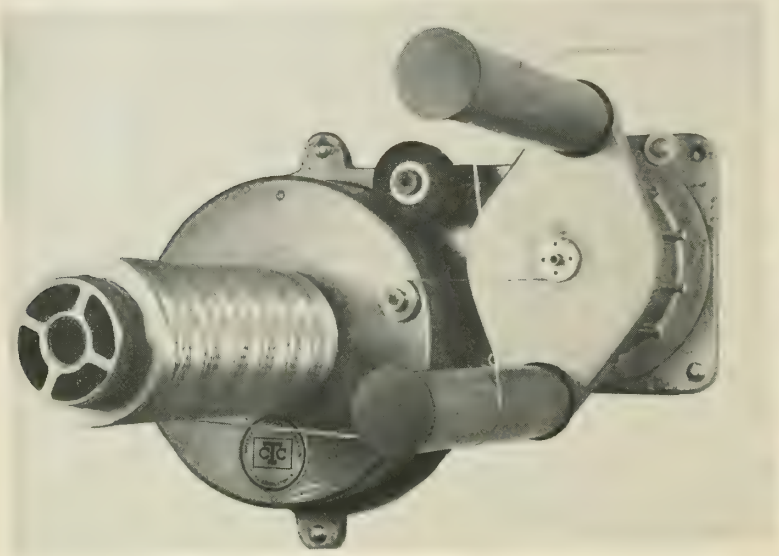
Lionel Corp. has contracted to sell the physical assets and inventory of its Denver-based subsidiary, Hathaway Instruments, Inc., for more than $2 million. Gulf-Southwest Capital Corp., Houston, heads a group of investors buying the firm. A spokesman for Lionel implied that the company is shedding some functions to concentrate on production of electronic components, certain electromechanical devices, and other products. . . . *In a separate transaction, Industrial Tectonics, Inc., precision bearing manufacturer, bought Continental Bearing Research Corp., New York City, which will be renamed ITI's Fluid film bearing Div. The purchasing company has headquarters in Compton, Calif.*

## New Facilities

The first actual move toward building Complex 39 at Canaveral has come with an Army Corps of Engineers request for bids on dredging a Banana River channel from the Merritt Island barge canal to the site. The 260-day project will require dredging 9 million cu. yds. of material to create the 125-ft.-wide, 10-ft. deep channel through which *C-5 Saturns* will move on barges to the assembly line. Bids will open Oct. 25 for the job, which is expected to cost about $4 million. . . . *Four New York firms have won a Corps of Engineers contract to prepare design criteria for the Complex 39 vertical assembly building. Cost of the 48-story structure may reach $85 million.* . . . Space Technology Laboratories, Inc., has established a Florida division at Cocoa Beach. Major elements of the new division will be launch and engineering analysis operations. . . . *Cornell Aeronautical Laboratory of Buffalo will open a new Washington Projects Office in Arlington, Va. Aimed at establishing more direct technical liaison with government, the office will draw personnel from Cornell's combat surveillance project, also in Arlington.* . . . Garrett-AiResearch of Los Angeles has consolidated its aerospace medicine and bioastronautics activities to form a new life sciences department. Aerospace medical director James Waggoner will head the new unit's research in the life sciences and projects concerning analysis of human and animal reactions during advanced space flights. . . . *Air Force take-over of a $500,000 addition to the Sunnyvale, Calif., Satellite Test Center next month will involve moving some military personnel from the nearby Lockheed Missiles & Space Co. plant. The 6594th Aerospace Test Wing, which operates the center, handles test shots of Discoverer, MIDAS, SAMOS, and other AF satellite systems.*

## Signed, Sold, Delivered

The Atomic Energy Commission has named suppliers of atomic fuel for nuclear rocket development. They are: United Nuclear Corp.; Metals & Controls, Inc., subsidiary of Texas Instruments, Inc.; The General Atomic Div. of General Dynamics Corp.; National Carbon Co.; and Aerojet-General Corp. . . . *New orders totaling $1.8 million for safing-and-arming devices for Minuteman brings its total order volume for such items in the past year to about $4.3 million, Bulova Research and Development Laboratories says.* . . . Schjeldahl Co. Northfield, Minn., has received a $200,000 contract from NASA for fabrication of two 135-ft.-dia. inflatable communication "Satelloons." Project will require about six months. . . . *Martin Co. at Orlando, Fla., has accepted from Electronic Specialty Co. a mobile instrumented support system van, to be used for checkout of Pershing missiles.*



## New Product of the Week:

## Fiber Tension Control Servo

A completely mechanical servo mechanism for controlling payout tension on spools of fiberglass roving and tape, dry or pre-impregnated, is available from Compensating Tension Controls, Inc. The unit holds a roving package up to 10 in. diameter by 10⅞ in. long and weighing up to 50 lbs. Two ranges are available, 0-5 lbs. for wet winding and 5-15 lbs. for pre-pregs. Tension is held to ±2.5% of the initial tension setting, maintained from full to empty spool. Tension is infinitely adjustable within the specified ranges. A fluid damping system is provided and the damping amount can be regulated.

Circle No. 225 on Subscriber Service Card

### Laser Crystals

"Guaranteed-to-lase" single crystals of neodymium-doped calcium tungstate are being marketed by Airtron, div. of Litton Industries. The crystals available with dopant levels to 1.0% are offered as ray crystals, rough-ground rods, or polished ready for use. Crystal orientation is available on either the "A" or "C" axis, and in special shapes.

Circle No. 226 on Subscriber Service Card

### Vacuum Diffusion Pump

A high-vacuum diffusion pump is available from Consolidated Vacuum Corp. with a speed of 18,000 L/sec. The PMC-18000 is designed for use in vacuum metallizing, electron beam melting, environmental testing, and a variety of other high-vacuum applications.

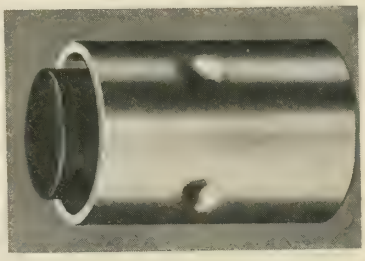
The pump has an insulated top nozzle which results in an extremely low backstreaming rate. The nozzle requires no coolant and hence no internal cooling connections.

Circle No. 227 on Subscriber Service Card

### Novel Electrical Connector

The Snail, a novel connector from Pylon Co., consists of a resilient, conductive elastomer cylinder that protrudes slightly from a loose-fitting container. The elastomer cylinder is free to expand radially while compressed axially, so that when connection is made, a gentle, positive, true area contact is achieved.

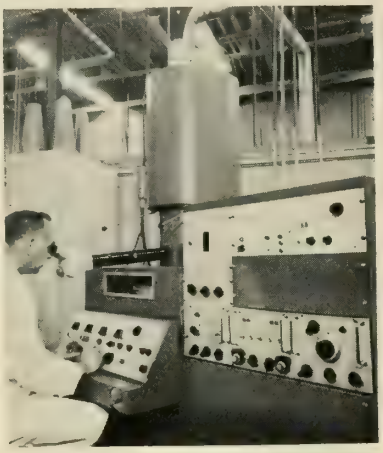
Originally designed for use in the electroluminescent lamp field, Snail connectors are ideal for making contact with any thin film where a vibration-proof, scratch-proof area connection is mandatory. Where multiple contacts are to be made in one plane, the suppleness of Snails make this possible with a minimum of total pressure.



Circle No. 228 on Subscriber Service Card

### Electron Beam Machine

An electron beam machine that can both cut and weld has been developed by Hamilton Standard division of United Aircraft Corp. The combination was designed primarily for fabricating and assembling microminiature electronic devices and can work all metallic materials and many non-metals such as ceramics and glass. Electrons shot from its gun pack 10-billion watts of power per square inch and the electron beam is focused down to a spot less than 0.0005-in. diameter.



Circle No. 229 on Subscriber Service Card

### Thermoelectric Cooler

Miniature two-stage thermoelectric coolers capable of achieving 97°C delta-T are being manufactured by Pesco Products Div., Borg-Warner Corp. The Pesco Model 094618 thermoelectric cooler is 0.65-in high without the enclosure, and is designed to operate over a wide range of hot junction temperatures up to 100°C. During operation in a vacuum of $10^{-6}$ torr, a no-load cold junction temperature of −70°C is maintained when using a hot junction temperature of 27°C.

The unit is available as a package, with a vacuum enclosure fabricated of either glass or Kovar and fitted with a sapphire window. A single pair of leads is used for the input power of 10 amperes at 0.18 volt dc. Other leads are provided for a detector, thermocouple, or other devices to be mounted within the enclosure.

Circle No. 230 on Subscriber Service Card

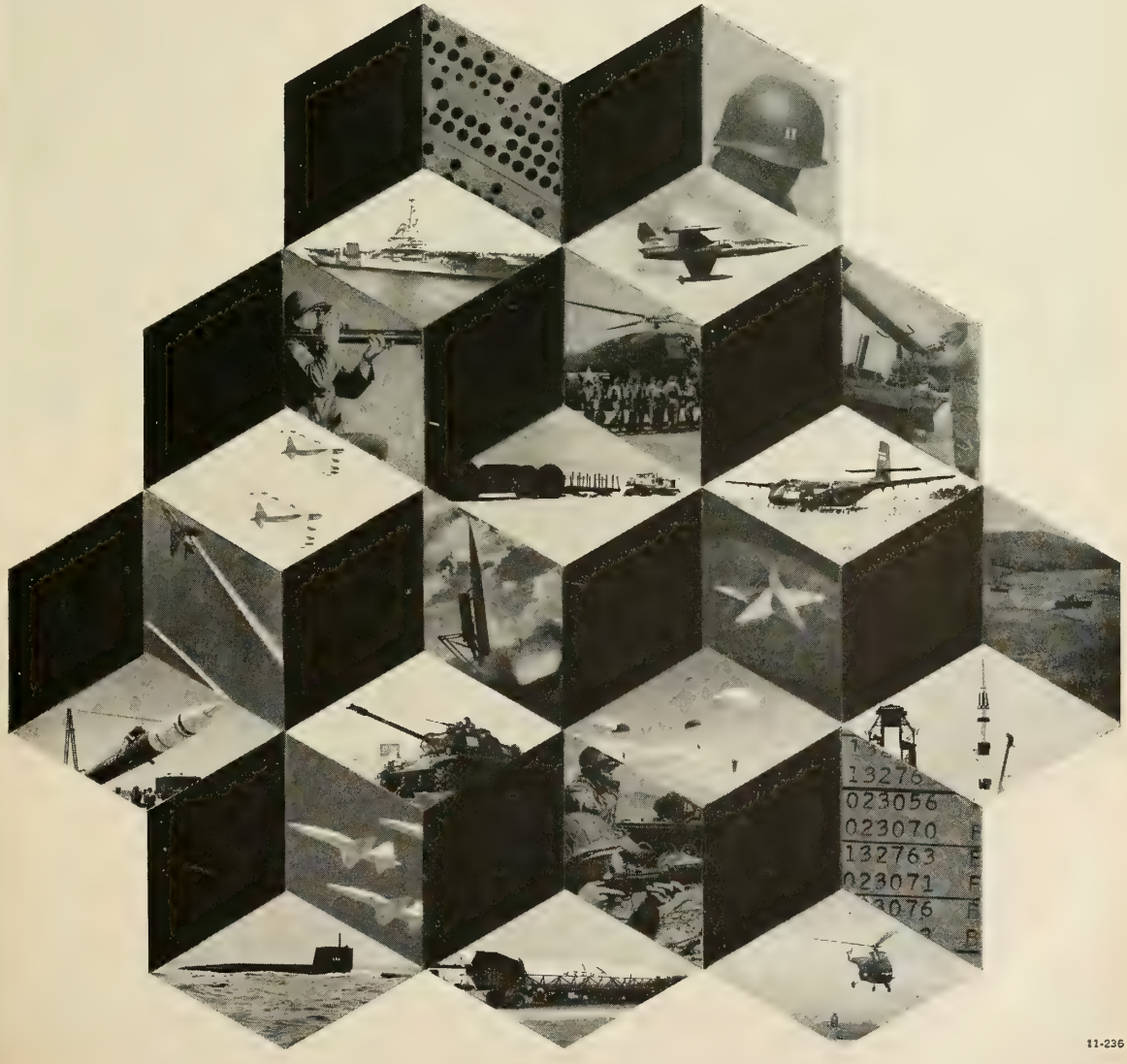
*The information behind such decisions is incredibly complex. In volume, in variables, in interrelationships. And each decision itself may affect world-wide or continental forces and events. In making operational decisions, today's commanders and governmental leaders use systems which provide information processing assistance. Developing these huge man-machine systems is the work of scientists, engineers, and computer programmers at System Development Corporation. Their concern is system development, not hardware development. They consider the interaction and effect of men, doctrine, tradition, training; of organizations, chains-of-command and chains-of-succession; of communications, traffic centers, command posts, computers and displays. Their work begins with system analysis. It continues through system synthesis, computer instruction, system training, system evaluation—and then in adapting the system to the changing needs of its users. Throughout they strive to optimize man-computer relationships and also carry on research into future systems. Human Factors Scientists, Operations Research Scientists, Systems-Oriented Engineers and Computer Programmers interested in joining this expanding field are invited to write Dr. H. A. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."*

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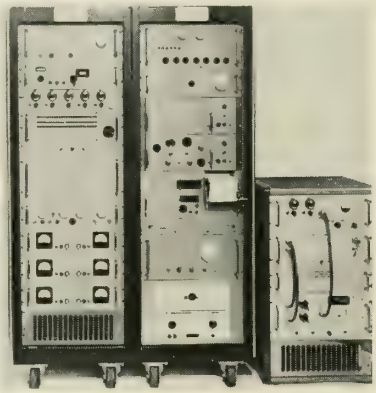
THERM

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## Hydrogen Line Radiometer

Triconix, Inc. a subsidiary of Tyco, Inc. has developed a low-noise, frequency-scanning hydrogen-line radiometer. The instrument will be used for detailed investigation of the radiation from neutral hydrogen atoms in outer space. The model HLR Radiometer achieves its low-noise figure through the use of an electron beam parametric amplifier operating in the synchronously pumped mode.

A low-loss ferrite switch at the radiometer input provides operation in the switched input mode and assures increased stability of the output baseline. The instrument features frequency scanning of several megacycles at any rate between 1 mc per hour and 40 mc per hour.



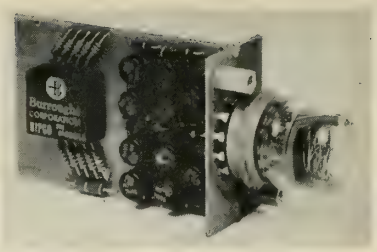
The receiver is constructed with two separate signal-processing channels to allow for comparison of the spectral density in narrow and broad frequency bands. The narrow bandwidth is selectable at 25 kc, 100 kc and 500 kc. Output integration time constant is selectable from 1 second to 100 seconds. The final output is presented on a two-channel chart recorder with a third pen that is used to provide crystal-controlled frequency markers at 100-kc intervals during the frequency scanning. The tuning range of the complete range of the radiometer is 1375 mc to 1425 mc.

Circle No. 237 on Subscriber Service Card

## Solid-State Decoder

Burroughs Corp. has developed a solid-state binary coded decimal-to-decimal decoder. The type BTR-58A accepts 8-4-2 binary information and provides visual in-line decimal readout of the data by use of a Nixie (R) indicator tube.

The decoder features use of a 90 silicon diode Bibco(TM) matrix package. The entire diode matrix is fabricated simultaneously from a single piece of silicon with diodes positioned to perform the decoding function. The diodes



are then joined to two circuit plates that provide input and output connections to the matrix. The inputs to the diode matrix are −6V or ground on each of the binary input lines. The outputs of the matrix connect to 10 transistor amplifiers that activate the decimal readout tube.

Circle No. 238 on Subscriber Service Card

## Wave and Tide Monitor

The Hytech Division of Bissett-Berman Corp. has developed a single passive sensor fluid level monitoring system. Known as Model 601, the instrument is an all-transistorized device for measurement of conductive fluid levels with an accuracy of 0.25%.

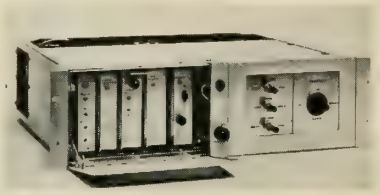
The staff, or sensor, is supplied in many configurations, and is essentially a Nichrome-alloy resistance wire applied in a continuous spiral around a polyethylene-jacketed stainless-steel cable. The sensor element is lightly imbedded in the polyethlene, thereby reducing the tendency of water to be channeled in grooves formed by the wrap. The degree and rate of on site fouling is minimal due to the applied ac potential. The dc output of the deck unit is monitorable by an integral meter readout, and is in a form acceptable by a recorder or telemetering VCO. The unit will operate on 24 vdc or 115 vac.

Circle No. 239 on Subscriber Service Card

## Control Unit

A solid-state closed circuit television control unit, with flexibility for a wide variety of systems applications, is being marketed by Cohu Electronics, Inc. The Model 1995CU is designed to accept trol circuits. Plug-in circuit assemblies either one or two complete camera conpermit choice of sync generators, which may be used for one or more control units.

Solid-state components are mounted on epoxy glass boards that make posi-



tive contact with quick-change connectors on the rack-mount chassis. Each of the two compartments is equipped with a door to provide easy access to all operating adjustments, which are on sub-panels of the circuit assemblies. The unit will operate in temperatures from −20°C to 55°C with up to 95% humidity.

Circle No. 240 on Subscriber Service Card

## Gyroscopic Stabilizer

A gyroscopic stabilizer that introduces stability to missiles and rockets at velocities ranging from zero to any proposed limit, and capable of functioning in any environment from the depth of the ocean to space, has been developed by Shelly Associates, Inc.

The guidance system aligns the thrust vector of a missile to a predetermined heading and stabilizes the space vehicle on this heading without further input signal. If required, it can also stabilize on a constant rate-of-change heading. The gyro-controlled nozzle lends itself to the "guided missile concept" by automatically locking on the latest command heading without the necessity of continuous input signals.

Circle No. 241 on Subscriber Service Card

## Input Converter

A unit for efficient conversion of 1-volt energy sources to a regulated 28 vdc at power levels up to 25 watts output is available from Lin Research Corp. Immediate application is foreseen in the conversion of voltages from thermoelectric devices, solar cell arrays, fuel cells and the like. Unit is especially designed to meet stringent environmental requirements associated with missile and satellite applications. Various military specifications are adhered to in component selection, fabrication and workmanship. The output is regulated against both line and load variations and is short-circuit proof.

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## Rare Earth Metals

Ronson Metals Corp. is marketing the high-purity rare earth metals such as cerium, lanthanum, CerAlloy 100X, Mischmetal, all of which have a purity of more than 99.9%. In addition, lanthanum metal is produced in a technical grade containing more than 85% lanthanum and less than 0.2 non-rare earth metal. Didymium metal contains approximately 3% magnesium, with the balance mainly neodymium and praseodymium. Cerium-free Mischmetal, which contains approximately 40% neodymium, 15% praseodymium and 40% lanthanum is also available.

Circle No. 243 on Subscriber Service Card


# Norair needs men with penetrating minds



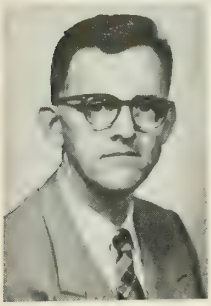
The men we're looking for will tackle many tough problems. Solutions won't come easy. But they'll find them. They have the kind of minds that aren't easily thwarted. If you're of this turn of mind, why not get in touch with us? With new areas of investigation and research constantly challenging us, we need hard-working dreamers to bring them into focus. These positions are available now:

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**Electromagnetics.** For studies in energy propagation and field theory pertinent to such areas as communications antennas, radar cross-sections, and plasma sheaths.
**Fluid mechanics.** For analyses of subsonic, supersonic and hypersonic flows.
**Communications.** To conduct analysis and integration of new concepts in telemetry command, detection, and tracking systems.
**Experimental aerodynamics.** To work with a group that will support theoretical aerodynamic research with experimental approaches and will initiate experimental research to fill voids in the theoretical techniques.
**Operations research.** To visualize complete weapons systems, and apply basic knowledge to new and diversified problems.
**Guidance and controls.** To conduct study and analysis of sensors and computers.
**Systems research.** To work on systems performance optimization.
**Numerical analysis.** To develop large-scale numerical procedures for aerodynamic design and flow field analysis.
**Avionics.** To work on the design, development, and analysis of avionics systems for airborne applications.
**Reliability.** To assess the reliability and optimize the configurations and mission profiles of space systems.
**Chemical research.** To work on the development and applications of structural adhesives for aerospace vehicles.
**Metallurgical research.** For research and development on materials and joining.

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## names in the news



CORCORAN



LING



CASSIDY

**Dr. Ernst Krause:** Elected a vice president of Aerospace Corp. and will serve as general manager of the San Bernardino, Calif. operations.

**Bernard Strassburg:** Assistant chief of the common carrier bureau with the FCC, will head the newly established office of satellite communications.

**William J. Corcoran:** Appointed director of the Research and Advanced Technology Div. at United Technology Corp., Sunnyvale, Calif.

**Eric A. Bardeen:** Appointed vice president and comptroller for Southern Electronics Engineering Co., Warner Robins, Ga.

**T. L. Maltby:** Appointed manager of weapon systems and missile engineering for Beech Aircraft Corp.'s Aerospace Div., Wichita, Kan.

**Wesley A. Peterson:** Elected a vice president of Land-Air, Inc., and will serve as general manager of the Instrument and Electronics Div., San Leandro, Calif.

**Joseph F. Houdek, Jr.:** Appointed director of manufacturing operations for all six divisions of the Elgin National Watch Co., Industrial Group, Elgin, Ill.

**Dr. Cheng Ling:** Named principal staff engineer in the research and advanced technology department of Martin Co.'s Electronic Systems and Product Div., Baltimore, Md.

**Col. Sanford H. Webster (USA ret.):** Joined Mark Systems, Inc., Los Altos, Calif., as manager of the market analysis department.

**Albert J. Kullas:** Director of engineering for the Martin Co.'s Denver, Colo., division has been appointed chairman of NASA's research advisory committee on missile and space vehicle structures.

**Jack Cassidy:** Elected president of Absoca Industries, Inglewood, Calif.

**Will M. Quinn, Jr.:** Appointed engineering manager of United Aircraft Corp.'s Norden division, Norwalk, Conn. **Carl F. Schaefer** named consulting engineer.

**Dr. Daryl Mitton:** Appointed vice president of sales and contracts for Straza Industries, San Diego, Calif.

**Dr. Morton Prince:** Appointed manager of the solid-state division of Electro-Optical Systems, Inc., Pasadena, Calif.

**Edward O. Bulkley:** Appointed manager of engineering applications and sales for the United GeoMeasurements Div. of United Electrodynamics, Inc., Pasadena, Calif.

**Richard D. Heaney:** Appointed director of manufacturing for Robertshaw-Fulton Controls Co.'s Aeronautical and Instrument Div., Anaheim, Calif.


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**Neil N. Saldinger:** Appointed vice president of engineering of Curvin Development Co., Van Nuys, Calif.

**Thomas P. Hudock:** Appointed vice president of finance and administration of Cook Electric Co., Chicago, Ill.

**Dr James E. Storer:** Appointed director, Applied Research Laboratory Sylvania Electronic Systems, Waltham, Mass.

**Ted Kaslow:** Named instrumentation planning engineer for Pan American's Guided Missile Range Div., Atlantic Missile Range.

**C. W. Finnigan:** Formerly with Sperry Rand Corp., named manager of communications on the advanced technology staff of Martin Co.'s Orlando Div., Fla. **W. L. Eddy** named assistant manager of communications in advanced programs and is responsible for new applications of RACEP.

**George H. Aklin:** Appointed chief lens designer at Fairchild Camera and Instrument Corp.'s Defense Products Div., Los Angeles, Calif.

**Robert F. Geiger:** Appointed director of engineering of Twin Industries Corp., Buffalo, N.Y. **Frederick J. Batson** appointed director of contracts and sales.

**William A. La Rue:** Appointed manager of federal government sales by Digitronics Corp., Albertson, N.Y.

**Joseph L. Borden:** Appointed director of engineering of the Vernistat Div., Perkin-Elmer Corp., Norwalk, Conn.

**Donald Reiser:** Promoted to vice president for instrumentation at Aero Geo Astro Corp., Alexandria, Va.

**Dr. Arthur R. Church:** Appointed materials scientist in the research and development laboratory of Swedlow, Inc., Los Angeles, Calif.

**David A. Williams:** Named manager of Standard Steel Corp.'s Cryogenic Div., Los Angeles, Calif.

**M. J. Weiner:** Joined Almay Research and Testing Corp., Los Angeles, Calif., as director of technical services.

**Allan E. Dean:** Appointed contract administrator for Wiggins Contractors, Los Angeles, Calif.

**Robert S. Erickson:** Appointed director of engineering of the Government Systems Div. of Control Data Corp., Minneapolis, Minn. **Arthur O. Hoistad** appointed director of manufacturing.

**Dr. Arthur L. Samuel:** Named editor of the IBM *Journal of Research and Development,* New York City.

**Lloyd L. Kelly:** Elected executive vice president of General Precision's Link Div., Binghamton, N.Y.


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# AWARDS

## AIR FORCE

$45,640,000—**North American Aviation, Inc.,** Downey, Calif., for production of *Minuteman* guidance control systems (2 supplemental contracts).

$39,566,000—**Avco Corp.'s Lycoming Div.,** Stratford, Conn., for production of a new generation of re-entry vehicles, for the *Minuteman* missile, known as Mark II.

$16,050,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for ground electronic systems development for *Minuteman* program (supplemental contracts). Work to be done at Buffalo, N. Y., Waltham and Needham, Mass.

$13,514,000—**Aerojet-General Corp.,** Sacramento, Calif., for *Minuteman* Stage II development program (2 supplemental contracts). Work to be done at Sacramento, Calif.

$12,000,000—**Radio Corp. of America,** New York City, for work on the Ballistic Missile Early Warning System (supplemental contract).

$7,000,000—**General Electric Co.,** New York City, for work on space vehicles (2 contracts). Work to be done at Philadelphia.

$6,500,000—**Carrier Air Conditioning Co.,** Syracuse, N. Y., for manufacture and installation of environmental control systems and associated equipment to be used at the *Minuteman* sites at Minot AFB and Whiteman AFB.

$5,800,000—**General Electric Co.,** New York City, for work on the *Titan II* weapon systems (supplemental contract). Work to be done at Philadelphia.

$5,000,000—**American Machine & Foundry Co.,** New York City, for work on *Titan I* launcher system (supplemental contract).

$4,800,000—**General Dynamics Corp.,** New York City, for *Titan II* launching sites and related equipment at Point Arguello, Calif.

$4,100,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on a classified program (supplemental contract).

$4,000,000—**General Precision Corp.,** Little Falls, N. J., for guidance and control equipment (supplemental contract).

$3,000,000—**General Dynamics Corp.,** New York City, for procurement of *Atlas* missile and related material. Work to be done at San Deigo, Calif.

$2,890,922—**Lockheed Aircraft Corp.,** Burbank, Calif for work on space systems (supplemental contract).

$2,617,000—**North American Aviation, Inc.** for provision of spares for *Hound Dog* missiles (supplemental contract).

$2,500,000—**Boeing Co.,** Seattle, for work on the *Minuteman* weapon system (supplemental contract).

$2,100,000—**Atlantic Research Corp.,** Alexandria, Va., for design, development, test, fabrication and launch of space test vehicles (supplemental contract). Work to be done at Arcadia, Calif.

$2,100,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for continuation of research and development for space programs.

$2,005,000—**Aerospace Corp.,** El Segundo, Calif., for systems engineering and technical direction of ballistic missile programs together with management services and administrative support.

$1,825,000—**Radio Corp. of America,** New York City, for emergency maintenance, supply support and depot level maintenance overhaul of radar equipment for FY-63. Work to be done at Moorestown, N. J.

$1,540,000—**Sperry Gyroscope Co.,** Great Neck, N.Y., for instrumentation of C-4 ships for Atlantic Missile Range.

$1,300,000—**Radio Corp. of America,** New York City, for provision of final-stage vehicles and services in support of space programs.

$1,250,000—**Thiokol Chemical Corp., Logan Works,** Logan, Utah, for production of tracked vehicles.

$1,108,000—**Martin Marietta Corp.,** New York City, for follow-on support and establishment of a rapid communications system for *Titan I* missiles.

$364,000—**Infrared Industries, Inc.,** Waltham, Mass., for infrared sensing component of the *Mauler* weapon system.

## ARMY

$145,976,431—**Western Electric Co.,** New York City, for continued testing and development of the *Nike-Zeus* antimissile system.

$6,892,456—**Raytheon Corp.,** Lexington, Mass., for engineering services in support of the *Hawk* missile system.

$3,882,449—**Raytheon Corp.,** Lexington, Mass., for a detailed field test plan for techniques and experiments applicable to the Advanced Research Projects Agency's Project *Defender* on advanced antimissile research.

$1,802,925—**Raytheon Corp.,** Lexington, Mass., for technical manuals for the *Hawk* missile system.

$1,400,478—**Universal Match Corp.,** St. Louis, for erector launchers for the *Pershing* weapons system.

## NAVY

$10,000,000—**Litton Systems, Inc., Data Systems Div.,** Canoga Park, Calif. for a transportable air operations control system to be used by the Marine Corps for integration of air defense units.

$2,177,471—**Western Electric Co.,** New York City, for engineering services in connection with a surface missile program. Work to be done at Winston-Salem, N.C.

$2,052,852—**Elgin National Watch Co.,** Los Angeles, for additional production of *Bullpup* missile fuses.

$1,998,245—**Hughes Aircraft Co.,** Culver City, Calif., for continued studies on the TFX missile system.

$1,195,523—**North American Aviation, Inc.,** Downey, Calif., for *Sparrow III* rocket motors.

$1,132,343—**Martin Co.,** Orlando, Fla., for production of a pre-packaged transmitter for the *Bullpup* guidance system.

$1,124,721—**Vitro Corp. of America,** Silver Spring, Md., for engineering services in connection with ship installation of *Talos, Tartar* and *Terrier* guided missiles.

$444,502—**Martin Co.,** Orlando, Fla., for design, development and production of Type-S launcher (2 contracts).

## NASA

$2,256,000—**Federal-Mogul—Bower Bearings, Inc., Arrowhead Products Div.,** Detroit, for design, development, test and documentation of ducting components for the *Saturn S-IC* launch vehicle.

## INDUSTRY

$1,700,000—**Jordan Electronics Div. of Victoreen Instrument Co.,** New York City, from **Sperry Utah Co.,** for continuation of the manufacture of guidance power supply for the Army's *Sergeant* missile.

$1,700,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., from **F. J. Stokes Corp.,** for construction of three space simulation chambers.

$500,000—**Lockheed Propulsion Co.,** Redlands, Calif., from **Hughes Aircraft Co.,** for development of a solid rocket motor for an advanced air-to-air missile.

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Secondary Item Branch
Procurement Div.
Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

Missile test stand, FSN 4935-733-4832. Ord P/N 10064320—24 each—IFB IXXF-ORD 01-021-63-10133—Bid opening 10-30-62. Drawings, specs and bid sets available from nearest ordnance district.

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Negotiations will be conducted with the Goodyear Aircraft Corp., Akron, Ohio, for a re-entry body with inflatable afterbody. RFP A2-1037. Note: For information only. RFP not available

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U.S. Army Missile Command
Redstone Arsenal, Ala.
Attn: AMCPM-SEPM

*Sergeant* supplemental shop equipment set, 14 each. Destinations to be furnished. Available specifications, plans or drawings relating to this procurement do not fully provide all necessary manufacturing and construction details. Request for proposal has been issued to Sperry Rand Corp., Sperry Utah Company Div., 322 North 21st St. West, Salt Lake City, Utah. Small business firms or others interested in subcontracting opportunities in connection with this procurement should make direct contact with that firm.

---

Deputy for Procurement
Air Proving Ground Center (PGKK)
Eglin Air Force Base, Fla.

Investigation of sub-miniature rocket is presently being accomplished under contract AF 08(635)-2211. The continuation of efforts under this contract with Ordnance Tech Corp., Walnut Creek, Calif., calls for further research effort. This notice is for information purposes only. Request for proposal not available. Request for proposal due date not furnished. Firms interested in subcontracting opportunities should contact above firm.

---

U.S. Army Engineer District, Baltimore
Corps of Engineers
24th and Maryland Ave.
P.O. Box 1715
Baltimore 3, Md.

Army Air Defense Program, *Nike-Hercules* improvements and radome facilities, sites PH-75C, Pa., W-26C, Md. and BA-18C, Md. Job—IFB ENG-18-020-63-11B. Bid opening O/A 10-25-62. Approximate value—$50,000—Site PH-75C & $75,000, Sites W-26C & BA-18C. Inv. is a set-aside for small business firms and will be awarded as such. Principal features: (a) Site PH-75C: construction of one 30' tracking radar tower and one 30' acquisition radar tower. Mod. of two 30' tracking radar towers and one 30' acquisition radar tower for radome facilities to be furnished and installed by the government. Construction of concrete ramp steps and sidewalks. (b) Site W-26C: construction of one 40' tracking radar tower. Mod. of two 20' tracking radar towers and one 20' acquisition radar tower for radome facilities to be furnished and installed by the government. Construction of concrete-paved ditch. (c) Site BA-18C: Construction of 20', 30' and 40' tracking radar towers and one 20' acquisition radar tower. Modification to existing wiring, conduits and equipment in generator building, concrete sidewalks, site grading, fencing and seeding all sites. 180 calendar days comp. time. Half-size drawings w/specs, $2.60 per set nonrefundable. Payments will be made by cash, check or money order, made payable to the Treasurer of the U.S. and forwarded to the above office, Attn: Finance and Accounting Officer.

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Supply Officer
U.S. Naval Research Laboratory
Washington 25, D. C.

System, closed loop, hydrotest, for automatic controlled and programed rapid pressurization of test chamber, using water as the hydraulic fluid. System to include electronic control console, hydraulic pressure source, and all necessary sensors, pressure controls, gauges, valves, hoses, etc. Systems to be capable of producing 10,000 psi maximum pressure during test time range 2 sec. to 10 min. and with typical test specimen volume of 3 gallons. Bidders must show previous design and fabrication experience in closed-loop, high-response rate, programable, fluid-pressurization systems—1 each. Deliver to: U.S. Naval Research Laboratory, Washington 25, D.C. RFP 173/N81024/63. RFP due date 10-29-62. Request for copies of this requirement should be received in writing no later than 10-11-62.

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# when and where

### OCTOBER

**Eighteenth Annual National Electronics Conference and Exhibition, sponsored by AIE, IRE, Illinois Institute of Technology, Northwestern University and University of Illinois,** McCormick Place, Chicago, Ill., Oct. 8-10.

**Conference on Ions in Flames and Rocket Exhaust,** El Mirador Hotel, Palm Springs, Calif., Oct. 10-12.

**Twentieth Annual Aerospace Electronics Exposition/Report, Aerospace Electrical Society,** Pan Pacific Auditorium, Los Angeles, Calif., Oct. 10-12.

**Symposium on Photography of Electronic Display,** Shoreham Hotel, Washington, D. C., Oct. 12-13.

**International Symposium on Space Phenomena and Measurement, sponsored by NASA and AEC,** Statler Hilton Hotel, Detroit, Mich., Oct. 15-18.

**Instrument Society of America's Seventeenth Annual Instrument-Automation Conference and Exhibit,** New York Coliseum and Hotel New Yorker, New York City, Oct. 15-18.

**Symposium on Inertial Guidance Test, sponsored by Air Force Missile Development Center,** Holloman Air Force Base, N. M., Oct. 16-17.

**Ninth Annual Joint ASLE-ASIE Lubrication Conference,** Hilton Hotel, Pittsburgh, Pa., Oct. 16-18.

**Fifteenth Pacific Coast Regional Meeting, American Ceramic Society,** Olympic Hotel, Seattle, Wash., Oct. 17-19.

**Electronic Industries Association Meeting,** Seattle, Wash., Oct. 17-21.

**Sixth Annual Display, Aerospace Electrical Society,** San Diego, Calif., Oct. 18-19.

**Ninth Annual East Coast Conference on Aerospace and Navigational Electronics, Emerson Hotel,** Baltimore, Md., Oct. 22-24.

**Society for Experimental Stress Analysis, Annual Meeting & Exposition,** Hotel Schroeder, Milwaukee, Wisc., Oct. 24-26.

**Seventeenth Midwest Quality Control Conference, American Society for Quality Control,** Denver Hilton Hotel, Denver, Colo., Oct. 26-27.

**Fourth Annual Western Technical Conference, American Institute of Electrical Engineers,** Biltmore Hotel, Los Angeles, Calif., Oct. 29.

**The World Metal Show and National Metal Conference,** New York Coliseum, New York City, Oct. 29-Nov. 2.

**Meeting on Large Rockets, IAS,** El Dorado Inn, Sacramento, Calif., Oct. 29-30.

**American Society of Safety Engineers First Technical Conference,** Morrison Hotel, Chicago, Ill., Oct. 29.

**Twelfth Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers, Inc., a division of Sperry Rand Corp.,** Pick-Ft. Shelby Hotel, Detroit, Mich., Oct. 29-30.


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# The Industry and the President

THE MISSILE/SPACE industry fight against imposition of a union shop by Presidential fiat is gathering momentum.

Ryan Aeronautical Co., although signing a contract with the United Auto Workers which calls for an employee vote on a union shop, has come out strongly against it.

"The company's opposition to the underlying principle of the union shop remains unchanged," says board chairman T. Claude Ryan. "We believe compulsory union membership is harmful to freedom of the individual worker, unnecessary for the well-being of the union, unfair to the employer and contrary to the public interest."

Mr. Ryan thus joins Chairman Courtlandt Gross of Lockheed in opposing the Presidential action (M/R, Sept 24, p. 64).

"We will put up the strongest possible battle against this," says a Ryan spokesman. The company is planning an all-out campaign to convince its employees that imposition of a union shop in this manner is not in their best interest.

Ryan's forthright action is even more to be applauded when it is realized the company is battling strong odds. It is not one of the industry's giants. With the Space Age shift in emphasis to research and development, the number of Ryan production workers has fallen from 5000 to somewhere around 1300. With this decline in production employment has come a corresponding increase in the percentage of the remaining workers who are union members.

Union membership at Ryan stands at approximately 70%, compared to 50% or less at Convair, North American and Lockheed. Much will depend on how successful the company is in alerting its production workers to the dangers inherent in President Kennedy's forcing of a union shop on the industry.

The provisions of the contract, as recommended by the Presidential advisory board, call for a two-thirds majority vote before a union shop is imposed. Ryan thus stands in more danger of an "automatic" vote than the other firms involved.

We hope the company can successfully bring these points home to its employees:

- President Kennedy's forcing of a union shop on the industry is an unwarranted use of Presidential power and an unsound labor practice. A number of union leaders are in disagreement with the method.

"This is a new idea the President's board is injecting into labor relations," an official of the International Association of Machinists states. "These things have a way of setting a precedent. We wouldn't want to see it legislated into law nationally."

- Such a method of settlement is contrary to accepted principles of collective bargaining as set forth in law and long followed in practice. The President has bypassed the Taft-Hartley law and violated the intent of Congress as to the approved way to settle labor disputes. The Presidential advisory board was not a mediation board but a group which made certain recommendations which the President is enforcing directly by using the formidable power of his office.

- President Kennedy is using the implied threat of withheld government contracts to enforce his desires. If the missile/space industry—and this includes its production workers—is forced to accede, it will have taken another long step down the road to complete government control, away from free enterprise and collective bargaining and toward socialism.

At his press conference on Sept. 26, we asked President Kennedy to comment on his action. He made the captive nature of the industry quite clear when he said: "Most of these missile companies, aerospace companies, are really very much dependent upon the government. The government is their major purchaser."

We believe the President has a duty to exercise extraordinary caution in protecting the rights of an industry in such a situation. We do not believe he has done so.

Commenting on the advisory board's recommendations, the President stated:

"The fact is the wage section of the report was not as generous as the unions felt that they must have. On the other hand, the union shop was unacceptable to some of the companies. But as I said the other day at a press conference, the union shop in major industries has been accepted for a great many years. Automobiles, steel, aluminum. This is not something new or radical."

THE KEY WORD in that paragraph, we believe, is *accepted*. There is no question, in this case, of acceptance. The union shop is being *forced* on the industry—and in a manner which even union officials find discomforting.

We are not finding fault with the President on a political basis. A strong President, he has demonstrated recognition and support of the industry to a far greater extent than his predecessor. This does not, however, entitle him to assume the role of dictator in regard to it. He should be reminded of this.

Ryan and Lockheed are leading the protest. We hope Boeing will join them.

And we hope the production workers at Ryan and elsewhere will act in the best interest of their country, their industry—and themselves.

**William J. Coughlin**

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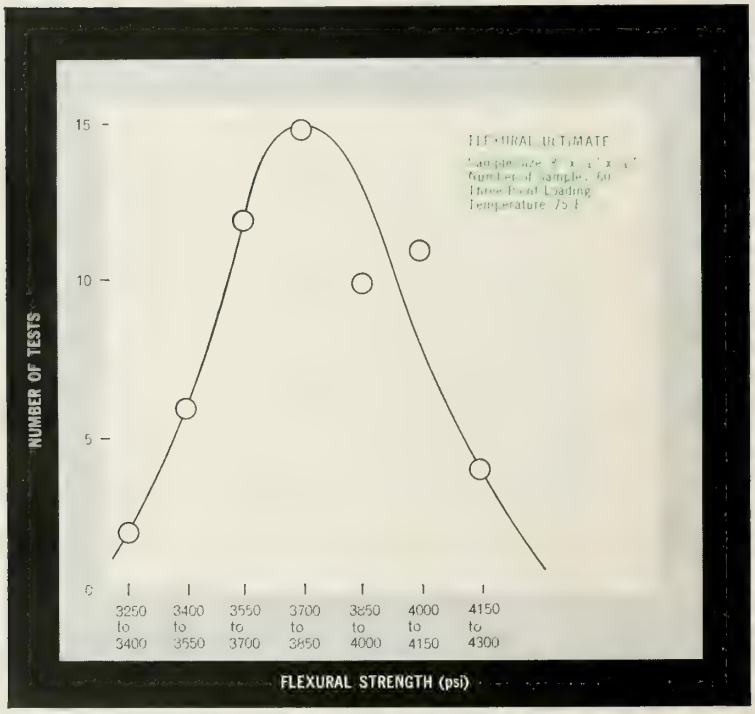
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OCTOBER 15, 1962

# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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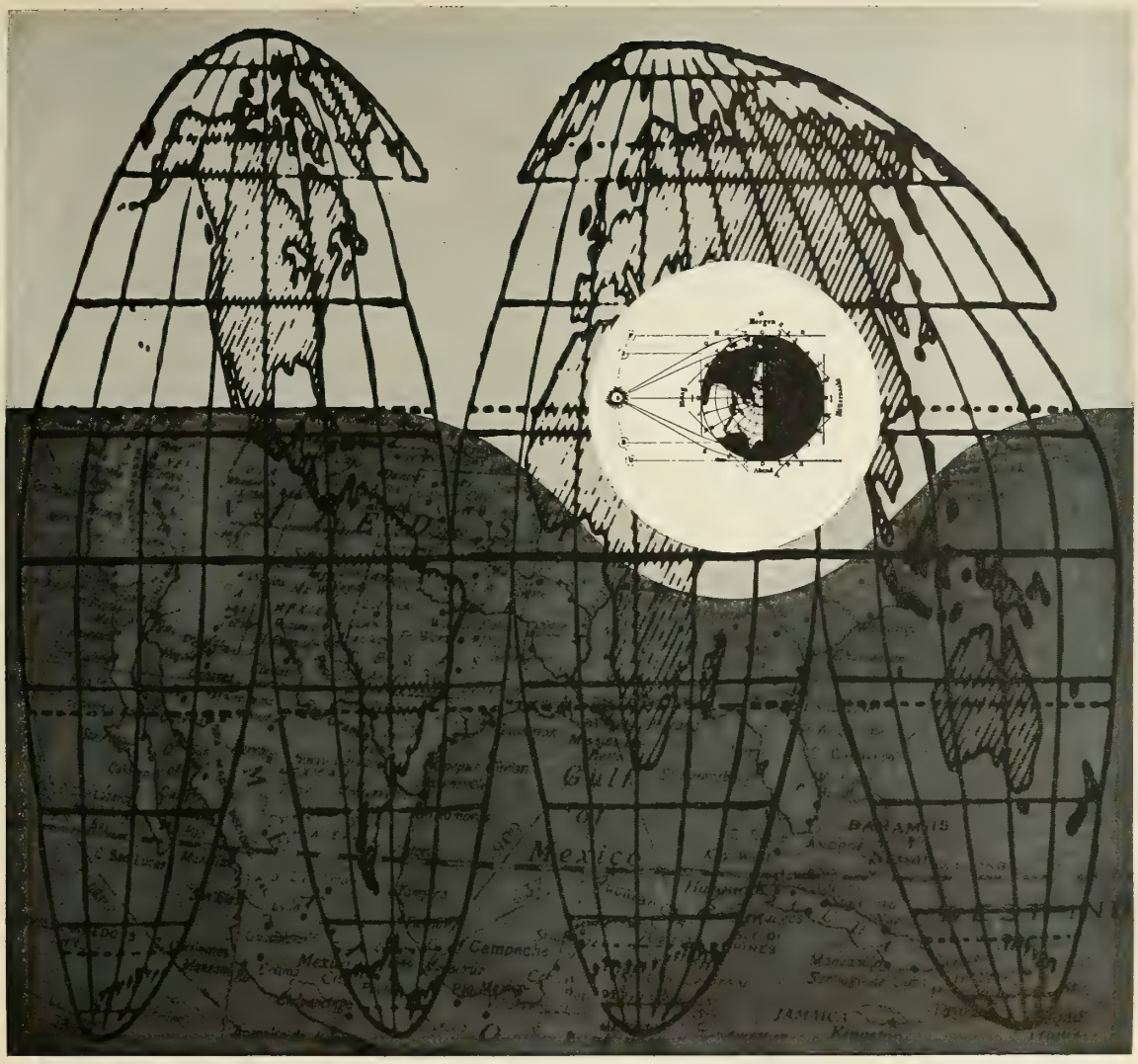
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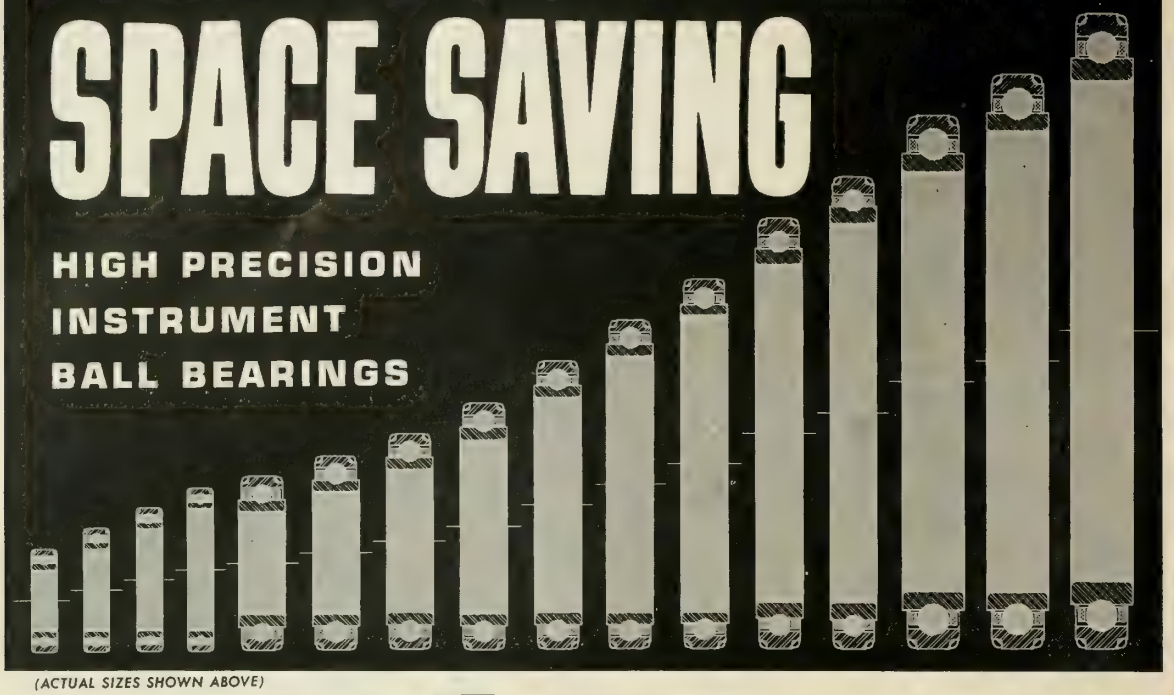

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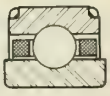
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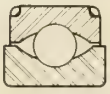




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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 16 October 15, 1962

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## THE COVER

*Lunar orbital flight and landings assume startling realism in this 3-degree-of-freedom Manned Spaceflight Simulator now in use at Chance Vought Div. of Ling-Temco-Vought, Inc., in Dallas.*



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# letters

## Shape of the Moon

*To the Editor:*

The cover of the Oct. 1 M/R is most interesting, but I fear that the caption is somewhat in error. It is claimed on your cover that the photograph denotes the "Moon's True Shape," by which, it is explained, you mean an annular eclipse silhouette of the Lunar disc. I commend to your attention a photograph on page 115 of *New Handbook of the Heavens,* by Bernhard, Bennett and Rice (McGraw-Hill, 1948), which shows a photograph of an annular eclipse made on April 7, 1940. This picture was taken at 13,000 feet, aiding in the lessening of atmospheric distortion.

Actually, due to the liberation effects of Lunar motion, there is no single "true" silhouette that the Moon can present. The actual situation depends on many factors; the edges can fall in a well defined zone, but the physical position within that region depends upon the precise positioning of the Moon with respect to the Earth and Sun. Were the Moon to have a perfectly circular orbit, most of these difficulties would disappear.

I would be the first to admit that in all probability these are the largest photographs of an annular eclipse. However, in order to preserve the accuracy of your fine magazine, I thought it would be better brought to your attention that previous photographs of annular eclipses have been made.

Stephen A. Kallis, Jr.
Huntsville, Ala.

## Sounding Off

*To the Editor:*

Congratulations on your Sept. 24 editorial ("Move Over, Mr. Blough"). Plain, outspoken, table-pounding expressions of opinion like this from more people who have strong opinions would be a great help in making this whole outfit hang together.

Thomas D. Boyd
Los Altos Hills, Calif.

*To the Editor:*

Once in a great while, in these days of catering journalism, a man sounds off to restore our faith and hope. Your editorial is such a sounding-off. It rings a powerful alarm.

We are sending it around to some important people with the hope some will respond to its challenge.

Glenn A. Green
Director of Information
National Right to Work Committee
Washington, D. C.

## Reflexes

*To the Editor:*

Your editorial "Playing with Blocks" (M/R, Aug. 27) certainly echoes the voice of dissent among the more knowledgeable persons working in the space business. And yet, the object of your, and our criticism, (the blatant rationalizations of people like Harold Brown, James Webb and others with access to classified information) may be statements tailored strictly for public consumption, just as television's outpourings reflect the pre-established level of the "average" viewing mentality. It seems hardly fair for the public, you and me, to demand a *factual* accounting from DOD officials on issues affecting national defense when: (1) we have no real right to classified information and (2) we are not in a position to evaluate the right or wrong of what DOD is doing to protect us. Unfortunately, it seems officials in Washington feel that some sort of "reflex" action is called for every time the Russians blast off, and about all they can come up with that is fit for news-service distribution is a bland statement devoid of any meaning and so completely nonsensical as to trigger one of two reactions: (1) these officials have lost their marbles, or (2) these officials are trying to soothe public indignation and keep the editorial writers at bay so that they can get back to the work at hand.

Your editorial was, I hope, not directed at the same group as were Mr. Rubel's remarks. People who bother with MISSILES AND ROCKETS at all are certainly not people who can believe such statements as, "We have not yet succeeded in defining a military need for man in space." Why should MISSILES AND ROCKETS, therefore, respond with a conditioned reflex to a "stimulus" that is obviously not meant to stimulate? Be certain, therefore, you are not rendering faithful readers a disservice with overconcern for public statements by big-name Pentagonians. There is enough real progress made weekly by hard-driving engineers and technicians to fill a space magazine ten times the dimension of M/R. Not to mention all the classified accomplishments and breakthroughs about which we can never be informed but must be constantly reminiscent.

Just one last word, fellas! If Secretary McNamara and his boys are not the sharpest and best available for the job of maintaining our nation's deterrent capability, you and others like you with a heavy responsibility to your readers had better help dig up some new names and start campaigning. There isn't really time remaining for more than one or two *more* gross mistakes.

Walter H. Trask
Santa Clara, Calif.

## Dyna-Soar GCA

*To the Editor:*

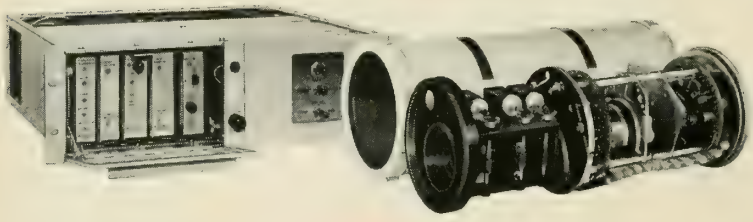
Since when is a ground-controlled-approach system a "mechanical control system" (M/R, Oct. 1, p. 32)?

George M. Bauer
Philadelphia, Pa.

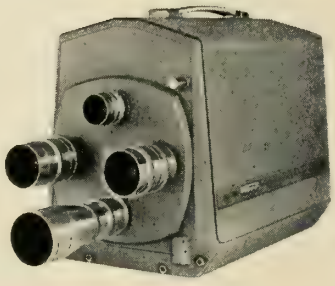
*The word, of course, should have been "technical."—Ed.*

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The 20/20 system consists of a self-contained camera that provides clear, 650-line resolution pictures and works with any TV monitor—with accessory, you can even use the TV receiver you have in your home. So sensitive, you get usable pictures with less light than is falling on this page. Low, 25 watt power consumption; easy-to-service, swing-out circuit boards; and transistor circuits make for trouble free operation.

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# The Countdown

## WASHINGTON

### MIT Will Develop LEM Guidance

Guidance system for the *Lunar Excursion Module* of the *Apollo* spacecraft will be developed by Massachusetts Institute of Technology. Still to be decided: whether contracts will go to the same industrial team which supports MIT on guidance for the other *Apollo* modules. *LEM* requirements are somewhat different. This means new contractors may be called in.

### Surveyor Set for Six-Month Orbit

First *Surveyor* spacecraft is scheduled to take pictures and gather scientific data for six months while orbiting the Moon. NASA still is planning a 1964 launch, although availability of the *Centaur* vehicle by then remains uncertain.

### MMRBM Future Still in Doubt

Despite recent narrowing of contractor competition, future of the Air Force's *Mobile Medium Range Ballistic Missile* still is doubtful. A Dept. of Defense official says the project is a long way from development approval. It may, however, move into the Phase I program definition stage within a month.

### Missile B Cutback is Feared

Army missile officials fear growth of special forces and Army aviation may force a cutback in funds for *Missile B*. Program approval still is expected, but a stretchout may be necessary to keep spending of scarce Army research funds within limits.

### NASA Schedules Program Briefing

NASA will brief the missile/space industry on its future program plans at a special meeting in Washington Feb. 11-12. The unclassified sessions also will cover patent and procurement policies.

### NASA Pushes Orbital Space Station

NASA is moving ahead with plans for development of its *Manned Orbiting Space Station*—although the program may run head-on into Air Force competition for the same funds (COUNTDOWN, Sept. 24, p. 9). The space agency has awarded a $79,487 contract to Lockheed Aircraft Corp. for study of an operational self-erecting space station.

### Project Westford Still Active

Dept. of Defense still is pushing Project *Westford* against strong scientific objections. Reason: Preliminary tests show that successful orbiting of the needle belt would make it possible to transmit large amounts of data processing information over long distances—a technique vital to improvement of U.S. early warning systems. The tests used the Moon as a passive reflector.

### AF May Develop Own TFX System

Dept. of Defense has okayed Air Force plans for development of a separate AF missile and fire control system for the TFX aircraft. Although Navy has awarded a study contract for its system to Hughes Aircraft, AF does not plan similar action until after further in-house study.

### BMEWS, Space Track Merger Seen

Next step in development of the Air Force space surveillance and tracking system (see p. 15) may be consolidation of the Ballistic Missile Early Warning System (474-L) and Space Track (496-L) into a single L-system.

## INDUSTRY

### Atlas Launch Vehicle Contract Due

Award of a $78-million Space Systems Division contract to General Dynamics/Astronautics for 35 Standardized Space Launch Vehicles for Air Force and NASA programs will cover the basic *Atlas* missile plus electronic systems kits containing telemetry, tracking and autopilot gear. Two types of radio-inertial guidance will be provided to permit launch from both Atlantic and Pacific Missile Ranges. Engines will be Rocketdyne MA-5's souped up to 380,000 lbs. thrust. First delivery is due in a year.

### First Ion Engine Due for Space Launch

Multiple-beam ion engine due to ride an Air Force *Blue Scout* into space before the end of next month (see p. 28) is believed to generate about one-tenth-lb.-thrust with neutralized beams provided by ionization of cesium propellant with heated tungsten buttons. The highly classified engine was built by Electro-Optical Systems, Inc., under a contract awarded in February, 1960. This is the first flight test of an operating electric propulsion system.

### Formal 120-in. Contract Signed with UTC

Interim Air Force contract for preliminary work on the 120-in. solid boosters for *Titan III* now has been signed by United Technology Corp. and Space Systems Division. Contract calls for preparation of a program plan which will cover design, fabrication, test schedules, preparations of preliminary model specifications and establishment of liaison with Martin Co. and Atlantic Missile Range. Award follows announcement last May 9 of preliminary negotiations.

## INTERNATIONAL

### British Missile Work Transferred

Work on the British *Swingfire* antitank missile formerly carried out by Fairey Co. Ltd. in its Weapons Division at Heston has been transferred to British Aircraft Corp. at Stevenage. Purpose: to put this and other missile work under one of the large missile/aircraft groups. Fairey has a 50% interest in the BAC subsidiary.

### Exports to Russia are Checked

Britain's Board of Trade has embargoed shipment of electron-beam welding and melting equipment to the Soviet Union. Reason: possibility of use in development of missile and space vehicles.

## Rubel Defends Space Program

DOD expenditures on space developments "have been remarkably high in relation to viable concepts for military applications in space," Assistant Secretary of Defense John H. Rubel told a meeting of the Aerospace Luncheon Club last week.

In a speech billed as "the most complete roundup of Defense views to date," Rubel pointed out that despite "extraordinary efforts" over the past few years, "no really new ideas for the military utilization of space have been evolved."

In spite of this, he said, DOD has increased the scope of its development effort by a factor of more than three over the last three years.

Rubel noted that "about half of our efforts are directed at clear, identifiable needs but that half of them are not, and comprise a very extensive program of technological insurance against an uncertain future."

In the first category, Rubel listed the development of communications satellite systems, navigational satellites, and a satellite system for ballistic missile warning.

The second major class of effort being supported by DOD is aimed at evolving new opportunities, at creating a vigorous and broad base of new technology and even of devices and systems for possible future application, "even though the requirements for these are incomplete or altogether absent."

These programs include *Titan III*, for which no specific military mission requirement presently exists. However, DOD feels that *Titan III* is an essential "building block," should future military space missions materialize.

Other exploratory and advanced developments aimed at evolving "technological building blocks" total $300 million and include: a variety of efforts in bioastronautics, the development of advanced sensors, the evolution of advanced propulsion systems and power supplies, developments in materials and a multitude of efforts to learn more about space flight and the space environment.

"Many of the applications that have been contemplated seem to us today to be unlikely if not infeasible," Rubel said. "Most manned military missions in space still, after years of study, seem little or no more viable than they ever did. The same may be said of many unmanned systems, especially systems employing offensive weapons in space," he added.

## Shots of the Week

- An Oct. 10 Air Force announcement revealed another secret firing from Vandenberg AFB—using a *Thor-Agena* booster complex, possibly for a *Discoverer* vehicle. Success or failure of the shot was not affirmed, and no other details were given.

- NASA pilot John McKay put *X-15* No. 2 to its most decisive reentry stability test Oct. 9. Test of the vehicle with its stability augmentation system shut off and its ventral fin removed was made at





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129,000 ft. and a speed of Mach 5.3.

McKay executed the most radical maneuvers of the *X-15* to date to determine effects of excessive yaw on re-entry.

• The third test flight of the *Polaris A-3* Oct. 5 was termed by Navy sources the best yet. First-stage burn was described as excellent. The second stage burned well until it went out of control near burnout and was destroyed by the range safety officer. *A-3* is designed for a 2500-nautical-mile range.

• An Air Force *Titan I* ICBM was successfully launched Oct. 6 from a silo lift facility at Vandenberg AFB by Strategic Air Command, contractor and AF Systems command personnel. Mission was further confirmation of total weapon system operation and obtaining added data for evaluation of various missile systems.

• A missile combat crew of SAC's 565th Strategic Missile Squadron from Warren AFB, Wyo., launched an *Atlas* ICBM from Vandenberg AFB on Oct. 2. It was part of a program allowing crews from operational sites to demonstrate readiness with actual launches at Vandenberg.

## ComSat Incorporators Named

President Kennedy last week named 13 incorporators to set up the communication satellite corporation. The following nominees are subject to Senate confirmation:

Edgar Kaiser, Kaiser industries, Lafayette, Calif.; David Kennedy, board chairman and chief executive of The National Bank and Trust Co., Chicago; Philip Graham, publisher of the *Washington Post and Times Herald;* Sidney Weinberg, director of several companies, including General Electric, Ford Motor Co., and B. F. Goodrich Co.

Also nominated were Bruce Sundlun, Washington attorney; Byrne Litschgi, Tampa, Fla., attorney; Beardsley Graham, president of Spindletop Research, Inc., Lexington, Ky.; Leonard Woodcock, vice president of United Automobile, Aircraft and Agricultural Workers of America, Grosse Point Park, Mich.; Sam Harris, New York attorney.

Also George Feldman, Boston, Washington and New York attorney; Leonard Marks, Washington attorney; John Connor, president of Merck and Co., Rahway, N.J.; and George Killion, president of American President Lines, Oakland, Calif.

## Ranger V To Try Moon Shots

This week, NASA will make its third attempt to take closeup pictures of the Moon with a *Ranger* spacecraft.

The launch of *Ranger V* from Cape Canaveral is scheduled for Oct. 16-19.

In addition to its camera work, it is also hoped that the 755-lb. spacecraft will gather information on the composition of the lunar surface and land an instrumented capsule on the Moon.

## Mariner-Venus Gap Widens

NASA scientists now report that the *Mariner II* spacecraft will miss Venus by some 20,900 miles.

Officials said that although the goal was a 10,000-mile fly-by, the greater distance will not destroy the spacecraft's ability to send back valuable scientific data.

*Mariner II* was launched on Aug. 27 on a trajectory which would have taken it 233,000 miles from the planet. On Sept. 4, a midcourse guidance correction was made and officials reported the spacecraft would pass within 9000 miles of Venus. Officials now report, however, that additional telemetry indicates the distance will be 20,900 miles.

## S-IV Passes Static Test

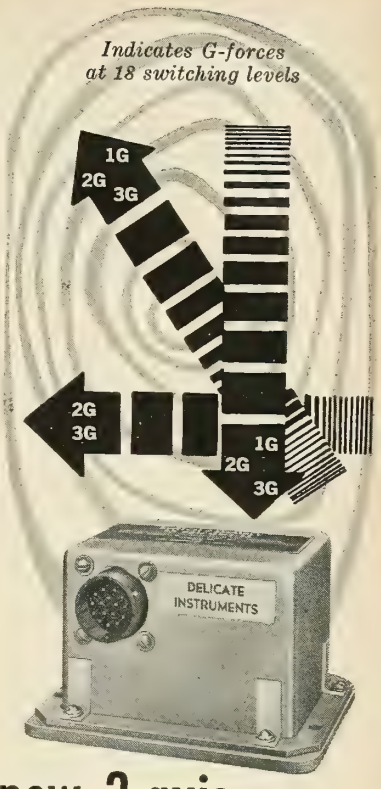
NASA chalked up another major milestone in its Project *Apollo* launch vehicle program with a full-flight-duration static test-firing of the *Saturn* booster's *S-IV* stage.

The *S-IV* test was conducted Oct. 5 at the Sacramento, Calif., test facility of Douglas Aircraft Co., prime contractor for the stage. It marked the first time the stage, composed of six Pratt & Whitney RL-10 engines, had been fired for a full seven minutes.

## MMRBM Contractor Omitted

A list of the contractors selected for continued work on the Air Force's *MMRBM* program published last week in MISSILES AND ROCKETS inadvertently omitted the Ford Instrument Div. of Sperry Rand Corp., which was selected as part of a team to continue study of the re-entry system for the missile.

Ford Instrument is the third member of the Aeronutronic-Fairchild Stratos Corp. team named to conduct further studies on the system.


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***More range, payload...***

# Advanced Minuteman Details Revealed

***Air Force adds airborne control center launch ability, redesigns second stage***

**by James Trainor**

FIRST DETAILS of the *Advanced Minuteman* ICBM were disclosed last week by the Air Force.

Development of the improved missile, with increased payload capability, is expected to cost between $400-$500 million over the next three to four years.

Already under active development by the Air Force with full support from the Dept. of Defense, the advanced solid-fueled ICBM is expected to become operational in 1965-66.

Study of the advanced version of the *Minuteman* was undertaken in May, 1961. During the eleven-month study which followed, industry, Air Force and the Dept. of Defense made recommendations on improving the payload-range capability of the system.

One of the most important improvements will be the ability to order launch of the *Minuteman* force from mobile control centers as well as from airborne control centers. If the Russians have any plans to destroy U.S. retaliation capability by attacking control centers, one Air Force official pointed out, the mobile launch control should disabuse them of this idea.

• **Second stage improved**—As a result of the study, most of the *Minuteman* improvements will be concentrated in the second stage. The study conclusively proved that the greatest range-payload improvements could be made at the least cost by developing a new second stage.

Some improvement in specific impulse will be made in the stage (presumably with boron additives), but the major gain will be achieved by replacing the present steel motor case with a titanium case. Although a fiberglas case is used in the *Minuteman* third stage and was considered for the improved second stage, the Air Force selected titanium because of a conviction that fiberglas wouldn't stand up under the bending moments of the missile's launch.

Several methods—including fluid injection—are being considered for the thrust vector control of the improved stage. The present stage is controlled by swiveling the nozzles.

A third area of stage improvement



*FREE FLIGHT test of Minuteman from Air Force Missile Test Center at Cape Canaveral.*

is optimization of the staging ratio. When the first development of the *Minuteman* was undertaken, a decision—dictated by both cost and schedule—was made to develop the missile off optimum staging ratio. Now, by optimization, a further gain in performance is possible. The first successful static firing of one version of the improved second stage already has been conducted.

• **Accuracy also improved**—In addition to the gain in range-payload capability, the *Advanced Minuteman* will have significantly improved accuracy. These improvements are basically modifications to the present guidance system through product improvement and the substitution of different components into the system.

Reduction of the CEP, although classified, is rather substantial, according to a Defense official. In the *Minuteman* program, he noted, "we have never been interested in just a 10-15 percent improvement but only in really significant advances. And I think it is safe to say that this applies to CEP."

The two other major changes in the *Advanced Minuteman* are the significant reduction of Aerospace Ground Equipment and the simplified launch control system. Reduction of AGE is expected to increase reliability. Simplification of the launch control system has made the system more redundant and invulnerable.

Both of these changes resulted from a review of the entire *Minuteman* system to see where it could be simplified. Since the ICBM was developed on a crash-program basis, it had not been optimized by one central authority. Instead, it was put together from equipment built by Boeing, Sylvania, other contractors or in-house by the Air Force. The review of the complete system eliminated much of the unavoidable duplication.

• **Flexibility gained**—When the *Advanced Minuteman* becomes operational in 1965-66, the range-payload of the missile will no longer be a restraint as far as basing is concerned. This means that *Minuteman* hardened and dispersed bases will have the ability to strike targets in the Soviet Union from bases in the southern U.S. or outside the U.S.

In addition, the *Advanced Minuteman* will give SAC a comfortable margin for the southward growth of targets within the Soviet Union.

Capable of replacing older versions of the *Minuteman* without extensive modifications to the silos, the advanced missile is expected to have the same per unit cost as the present version—approximately $3.5 million in the silo.

Initially, *Minuteman* was an "all or nothing" system in which all the missiles were salvoed. As the system is improved, however, a selective response will be possible in which all, several, or just one *Minuteman* can be fired.

Finally, the increased range-payload will enable each missile to carry a greater number of penetration aids as well as an increased yield warhead. A new re-entry body for *Minuteman* is under development to take maximum advantage of this increased capability. ⌗

## NASA prompts review...

# Apollo Contractors Move to Cut Costs

### Generalized effort to trim excesses out of program will continue for two months

by Russell Hawkes

DOWNEY, CALIF.—*Apollo* contractors have embarked on an intensive effort to cut costs and make more realistic cost projections in response to concern voiced by NASA officials D. Brainerd Holmes and Robert Gilruth (M/R, Oct. 8, p. 16).

A comprehensive program review, expected to continue for about another 60 days, will reassess all aspects of the program—with special attention to test requirements, simulator programs and computer operations. The level of technical sophistication required in some *Apollo* subsystems is also being reconsidered.

John W. Paup, *Apollo* program manager for North American Aviation's Space and Information Systems Division (SISD), told MISSILES AND ROCKETS the cost review is a generalized effort to squeeze fat out of the program and is not aimed at reducing costs to any specific level.

He cited two reasons for the excessive growth of *Apollo* costs, one quite common to large space and defense programs and one peculiar to *Apollo*. The first was the broad and general nature of work statements negotiated with all contractors at the outset of the program, which permitted a lot of duplication in planning. The second was an odd tendency of contractors to ignore their own management experience in other programs because of a feeling that the unprecedented scale and spectacular goal of the program put it beyond the scope of proven methods.

Paup said NASA and the contractor team headed by SISD are now in the process of making work statements more specific. All contractors have been encouraged to challenge their own and each other's stated requirements, and Manned Spacecraft Center chief Gilruth has advised Paup that not even NASA requirements are to be considered sacred. Paup said contractors have shown no reluctance to make or accept suggestions. Uncertainties about who is to perform certain component and subsystem tests, data reduction tasks and simulator programs are now being resolved.

Paup will soon contact major suppliers to ask them to challenge SISD requirements and to give them a feedback on what SISD is doing in its own shop to eliminate marginally useful tasks and requirements. As one step, SISD has dropped plans for some mock-ups and boilerplate models originally scheduled for erection in Teepee Town: at the Downey, Calif. plant. The reduction in the number of these models is about 10%, but the cost saving may be somewhat more or less than that.

• **Two fronts**—The industrial team is mounting a two-pronged attack to bring the experience of previous programs into *Apollo*. One part is an analysis of the specific tasks to be performed by the various contractors and a review of the methods used on similar tests in projects within the experience of people and companies now employed in the *Apollo* program.

At the same time, the team is making a detailed study of the progress of other major programs by reference to such indicators as the number of engineering drawings produced, the number of computer hours required and the number of engineering man-hours expended. Paup said that as the *Apollo* industrial team learns to draw on experience gained in similar elements of such other programs as *Mercury, Gemini, X-20 (Dyna-Soar)* and *X-15, Apollo* cost and schedule projections are becoming more accurate.

As part of the cost-cutting program, some fundamental *Apollo* design philosophies are being questioned. Paup said "In *Apollo* we must get extreme reliability during a considerable period of time during which little or no maintenance will be possible. Since the number of *Apollo* vehicles to be built and flown will be small, the reliability of the system must be determined by ground tests and the number of these establishes the level of our confidence in our estimate of that reliability. Now we are trying to learn the cost of different confidence levels. It may be that we can reduce the amount of testing considerably without lowering our confidence in the reliability estimate very much."

At present, SISD officials believe the *Apollo* schedule is realistic, and they expect to meet program milestones on time. The goal of the big cost-cutting program is to get the maximum reduction that can be had without any radical schedule changes.

• **Simplification**—Efforts, not necessarily a part of the cost-reduction program, are being made to simplify the design of the *Apollo* vehicle. These can be expected to reduce costs by eliminating some design tasks and by cutting the number of items to be tested. "We ask ourselves," Paup said, "if this item failed during the countdown, would you still launch? If the answer is yes, why carry it at all?"

Simplification of on-board electronics may result from changes being considered for the Ground Operations Support Systems (GOSS) coordinated network of stations that will handle tracking, telemetry and communications responsibilities. NASA criticism of cost estimates for the *Apollo* guidance and navigation system was particularly strong, but SISD officials would not comment on it because the system is being developed by a separate industrial team under the leadership of associate contractor Massachusetts Institute of Technology, and is received by SISD as government-supplied equipment.

(An MIT spokesman noted that MIT has only technical supervision of the guidance team, and does not control cost estimates of industry members. He said MIT's own costs were "well within" its first estimates. Spokesmen for industry firms denied that they had had overruns—or declined to comment.)

As in all present large programs, successive phase of research, development, test and production will overlap chronologically. This entails some risk to cost estimates. The degree of concurrency will probably be low for subsystems which can rely on the technology developed in the missile program and earlier space programs. However, subsystems needed for the totally new business of deep spaceflight, lunar operations, and atmospheric re-entry at lunar-return velocity will require a high degree of concurrency. ⌘

***Administration seeks backing . . .***

# New Study of Space Benefits Weighed

***Urey may be picked to head special committee reporting on advantages accruing from costly program; MA-8 stirs confidence***

**by Hal Taylor**

THE KENNEDY Administration is considering establishment of a special ad hoc committee to study benefits of the U.S. space exploration program.

Informed sources report that Dr. Harold B. Urey, University of California scientist, may be selected to head the group.

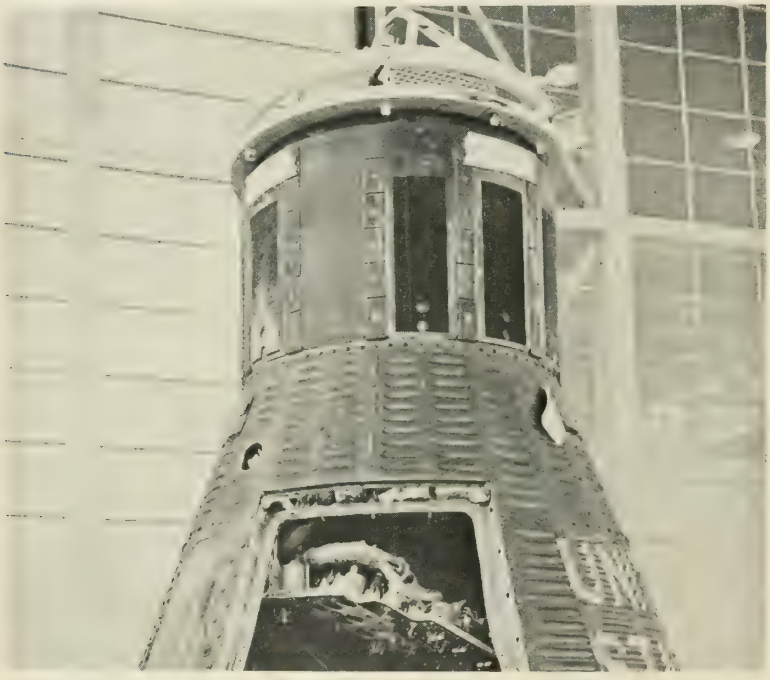
A White House official admitted that the committee study is being considered by the Administration. No decision has yet been made.

"We feel that there are benefits to be derived from a careful analysis and delineation of the large number of reasons for space exploration," he said.

Possible establishment of the committee makes it apparent that the Kennedy Administration believes more public support must be generated.

The space program—both civilian and military—is reaching the point where the already heavy costs will soar even higher. The space budget will jump to about $7 billion in Fiscal 1964, and total budgets of $8-$9 billion in the years following are almost certain.

The committee study probably will also be concerned with the military importance of space and the role of Dept. of Defense in space programs.



*CLOSEUP of upper portion of Astronaut Walter Schirra's MA-8 capsule shows shingles of ablative material around neck. Shingle at left clearly reveals burn marks.*

• **Ability proven**—The official indication that the U.S. space program needs even more vindication came in the face of another successful manned space flight which space agency officials said proved that the *Mercury* spacecraft is operational and that the U.S. has the technical launch competence to execute rendezvous missions.

Astronaut Walter M. Schirra hailed the flight as an engineering success and declared that it proved the spacecraft was operational for a one-day mission next year.

The rendezvous capability was claimed by NASA officials at the *Mercury* Control Center at Cape Canaveral.

Schirra declared that he had no trouble maintaining attitude at any point during the flight. "Even while drifting," he told a press conference, "I could determine almost exactly what my yaw attitude was."

He also reported he suffered no space sickness during the flight. "There were no breakoff phenomena, there was no uneasiness, there was no queasiness. I felt great and I would have liked to continue for 12 more orbits," the astronaut said.

Schirra also disclosed that at one point during the flight, he flipped a switch cutting off all ground control of the spacecraft.

He said he took the prearranged step to "prove that it was my capsule."

## *Spacesuit Heating Believed Solved*

MERCURY OFFICIALS say they think they have licked the spacesuit heating problem that almost forced abortion of Walter Schirra's flight after the first orbit.

Although the cooling system is still undergoing rigorous testing, Dr. Charles Berry, *MA-8* flight surgeon, said the problem seems to have been in finding the right setting for the control. In ground simulations, the eight-notch dial was set at about 3 or 4. However, in weightlessness, Schirra proved that it had to be about 7½ to 8. Future flights will probably start out with that control setting.

Weightlessness seems to pose no problems to the astronaut in his ability to sense his position with respect to his capsule and the ground, Dr. Berry told M/R. Schirra completed two simple tests with his eyes closed during each orbit, and in each was able to tell were his instruments were and what his position was. In fact, he became extremely proficient at it toward the flight's end.

Schirra also confirmed the "fireflies" reported by Astronauts John Glenn, Jr. and M. Scott Carpenter. He said he believed they originated from the capsule surface.

• **Better craft** — *Mercury* Control Center officials credited the remarkable operation of *MA-8* spacecraft to the fact that *Mercury* officials froze modifications more than two months before the flight.

They said that the decision "gave Schirra a better spacecraft."

The briefing officers pointed out that Schirra "stuck closer to his flight plan than Glenn or Carpenter," but added that this resulted from trouble-free operation of *MA-8*. Glenn experienced trouble with his thrusters and Carpenter had difficulties with the horizon scanners.

No attempt was made to assess the value of the 13.5-ft.-long "rabbit-ear" antennas carried on *MA-8*. It was pointed that out the flight was made during "a bad day for radio."

Performance of the booster was well within *Mercury* flight tolerances; the spacecraft achieved a trajectory that could have continued for at least 80 orbits.

Present plans for *MA-9*, the next *Mercury* flight, call for the same booster cutoff as in the *MA-8* flight, with no increase in booster performance.

• **Weight problem** — The briefers said the *MA-9* probably will weigh less than Schirra's *Sigma 7*, to increase insertion probabilities and assure that the weight can be handled by the retro rockets. They said it "definitely" will not weigh more than *MA-8*.

There was no clear-cut indication of where weight will be saved in the *MA-9* capsule.

The briefers said the one-day spacecraft will need more redundant systems, additional fuel and extended life support facilities.

A tank will carry an additional 15 lbs. of fuel to back up the manual and automatic attitude control systems. The reserve tank will be connected with both systems for use as needed.

Other increases include more batteries, additional oxygen for breathing, more water for drinking and suit temperature control, and an extra pound of lithium hydroxide for removing carbon dioxide fro mthe air.

The tracking network will undergo few changes for the *MA-9* mission. To accomplish the requirement of at least one command capability for each orbit, the Pacific command ship used for *MA-8* will be shifted to a point off the west coast of South America. The Indian Ocean ship will remain in the same position it occupied during the last *Mercury* flight. ⌗

***With SPADATS award . . .***

# AF Starts to Build Detection Net for '70's

A CONTRACT AWARD to the Bendix Corp. to design, develop and build the giant SPADATS radar is the first step in development of an Aerospace Surveillance and Warning System for detecting satellites out to cislunar ranges. Contract for the multimillion-dollar radar was awarded last week.

One of the two key elements of the Air Force's Specific Operating Requirement (SOR) 197, the SPADATS radar —named for the Air Defense Command's Space Detection and Tracking Systems at Colorado Springs, Colo.— is a prototype radar which will be built and tested at Eglin AFB, Fla.

The radar, 330 ft. long and 144 ft. high, is a phased-array system which scans electronically and is therefore capable of tracking many separate objects concurrently. The active array elements are set on an angle of inclination of 45°.

The SPADATS radar is expected to be ready for testing April 1, 1964, with a nine-month evaluation and testing period to follow immediately. In the joint Army/Navy/Air Force nomenclature, the SPADATS radar is known officially as the AN/FPS-85.

There are no present plans to buy or build more than one AN/FPS-85. The Air Force expects to learn from the SPADATS radar test program and to take advantage of improvements in techniques and components so that the next radar procured for the Aerospace Surveillance and Warning System would be a markedly improved AN/FPS-86. For example, the FPS-85 will operate on an off-optimum frequency of 446 mc. By developing the L and S bands, the capability of the radar could be increased.

The second key element to be developed under SOR 197 is a Prototype-Optical Surveillance System (POSS) that can detect space objects at extremely long ranges and, at the same time, is extremely inexpensive to build. Also the system has a real-time capability.

An electro-optical system, POSS will be built and tested at Cloudcroft, N.M., not far from Holloman AFB and White Sands Missile Range. The first system is expected to be ready for test in June 1964; since the POSS testing period is shorter, POSS and FPS-85

• **AFSC studying system**—Meanwhile, the Air Force Systems Command is studying the operational requirements of SOR 197 for an Aerospace Surveillance and Warning System. The study, expected to be finished by the end of November, will determine the numbers and types of radars and other sensors required to meet the anticipated population of space objects by 1970 as well as the threat posed by low re-entry angle ballistic missiles, submarine-launched missiles, extended range ballistic missiles and orbital bombardment systems. More accurate cost estimates for SOR 197 also are to be evolved from this study. Present estimates range from $300 million to $1 billion to produce the Surveillance and Detection system.

The importance of this study is emphasized by the fact that if only the capability to detect and define the orbital parameters on the first orbit is desired, only six or seven AN/FPS-85 radars are needed. These would be deployed on half of a great circle, some aboard ships.

But if a system is desired to shoot down satellites, the network would have to cover the North American continent, and approximately 20 radars would be required.

The approach favored by a large number of Defense officials is to develop a Surveillance and Detection system specifically designed to meet the 1970 threat. Admittedly this approach would be more expensive to develop than it would be to modify the present Space Surveillance network, but in the long run it would be cheaper because it would not require constant updating.

The ultimate goal—for which provisions have been made in the FY '64 budget in anticipation of the AFSC study—is to meld this "hodgepodge" of things into one system adequate to the threat. Once this is accomplished, the system can be added to for defensive purposes as the threat evolves.

The AN/FPS-85 and POSS are the first steps in this direction. ⌗

***Study funds sought for FY '64...***

# NASA Eyes Navigation Satellites

INDUSTRIAL STUDY contracts will be awarded next year as NASA moves toward development of a navigational satellite system.

The contractors will determine the feasibility, requirements and best method of establishing the system.

Data will also be sought as to how or if the current DOD *Transit* satellite technology can be implemented.

A space agency official disclosed that funding for the studies is included in NASA's proposed Fiscal 1964 budget, now being considered by the Kennedy Administration.

He emphasized that the system still does not have program status, but he admitted that "we are looking at it sympathetically."

NASA's detailed position was revealed to the National Electronics Conference in Chicago by the space agency's director of navigational satellites, Capt. Alton B. Moody, USNR.

He told the conference that navigational satellites will soon have an opportunity to prove their military usefulness.

"Non-military requirements," he continued, "being more varied, are in some respects more difficult to meet, but the benefits to be derived from success appear to warrant the attempt."

Moody said use of *Transit* technology for the non-military system is "intriguing," but that it might prove too costly for non-military users.

He also said that, because of significant state-of-the-art advances since *Transit* was begun, "careful consideration must be given to other promising techniques."

*Transit* is based on the Doppler Range Rate system, which utilizes signals from two harmonically related radio frequencies in the band-eight or lower band-nine areas.

Because the 600-mile optimum orbit of *Transit* lacks stability, users are forced to inject new orbital data into their computations every 12 hours. A complex computer is also required.

Because of still-unanswered questions concerning suitability and availability of *Transit* for the non-military systems, Moody said three other techniques—range, elevation angle, and horizontal angle—must be studied.

• **Range**—This technique involves the measurement of distance between the observer and the satellite. Two such measurements separated in time sufficiently to permit adequate change in azimuth provide a fix, but a third reading may be needed to eliminate the ambiguity of two possible positions on opposite sides of the track.

Range might be measured by primary radar if sufficient power were available, but more promising method use of a transponder in the satellite. The use of synchorinex clocks in the spacecraft and at the observer has been suggested, but is considered beyond the state-of-the-art at present. If a frequency between about 300 mc and 700 mc is used, relative simpicity of user equipment makes this technique particularly promising for use by aircraft. If cooperating ground stations are used, reasonably good accuracy can be achieved with extremely simple mobile equipment. However, the technique has relatively poor spectrum economy.

• **Elevation angle**—The elevation angle technique is the ordinary celestial navigation approach with radio signals in the gigacycle region replacing visual observation. One observation provides a line of position, and two observations provide a fix.

Simultaneous observations of altitude and its first-time derivitive would also provide a fix by means of orthogonal lines of position. With minor modification, radio sextants designed for use with the sun could be used for making the observations, providing a dual capability to extend the usefulness of the system and decreasing its vulnerability to malfunction or malicious damage.

Stable orbits can be used, minimizing dependence on ground installations and reducing the complexity of the satellite components. Computational requirements are modest. The technique is capable of providing accurate directional (north) reference. However, a stabilized directional receiving antenna about three feet in diameter would be needed for high accuracy.

• **Horizontal angle**—The horizontal angle technique involves measurement of azimuth of the satellite; two such measurements sufficiently separated provide a fix. Other approaches would be simultaneous observations of azimuth and its first-time derivative, or of altitude and azimuth. Stable orbits can be used, and computational requirements are modes.

A reference (north) direction indicator with high short-term stability, a directional antenna and a stabilization system with moderate short-term stability would be required, making this approach somewhat less attractive than the others. ⌗

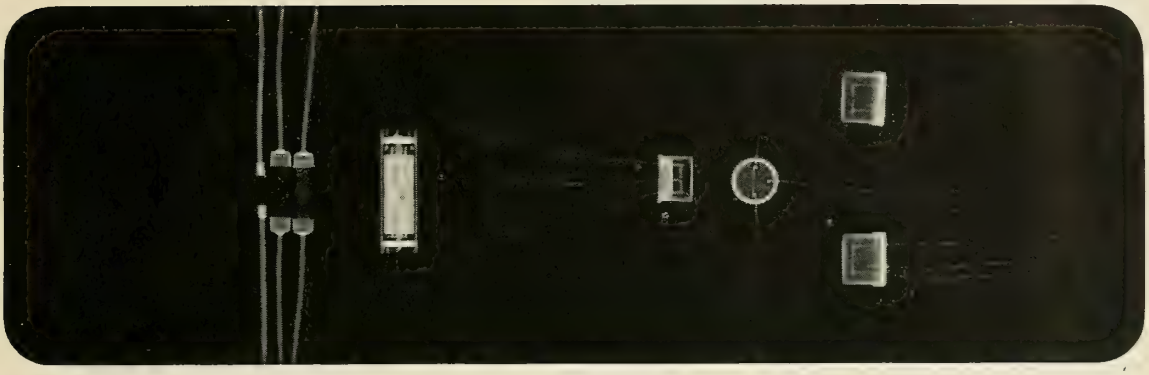


## Gemini Model Takes Re-entry Heat

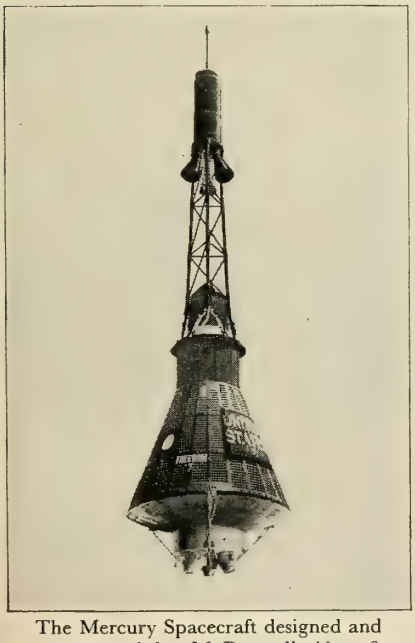
*STAINLESS STEEL scale model of NASA's two-man Gemini space capsule glows in recent test in 50-in. Mach 10 tunnel of Von Karman Gas Dynamics Facility at AF's Arnold Engineering Development Center. Model is in 15-degree nose down re-entry position.*

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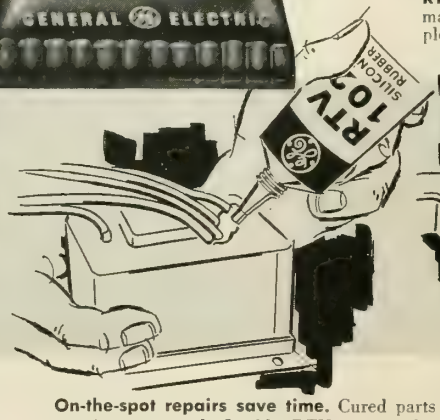


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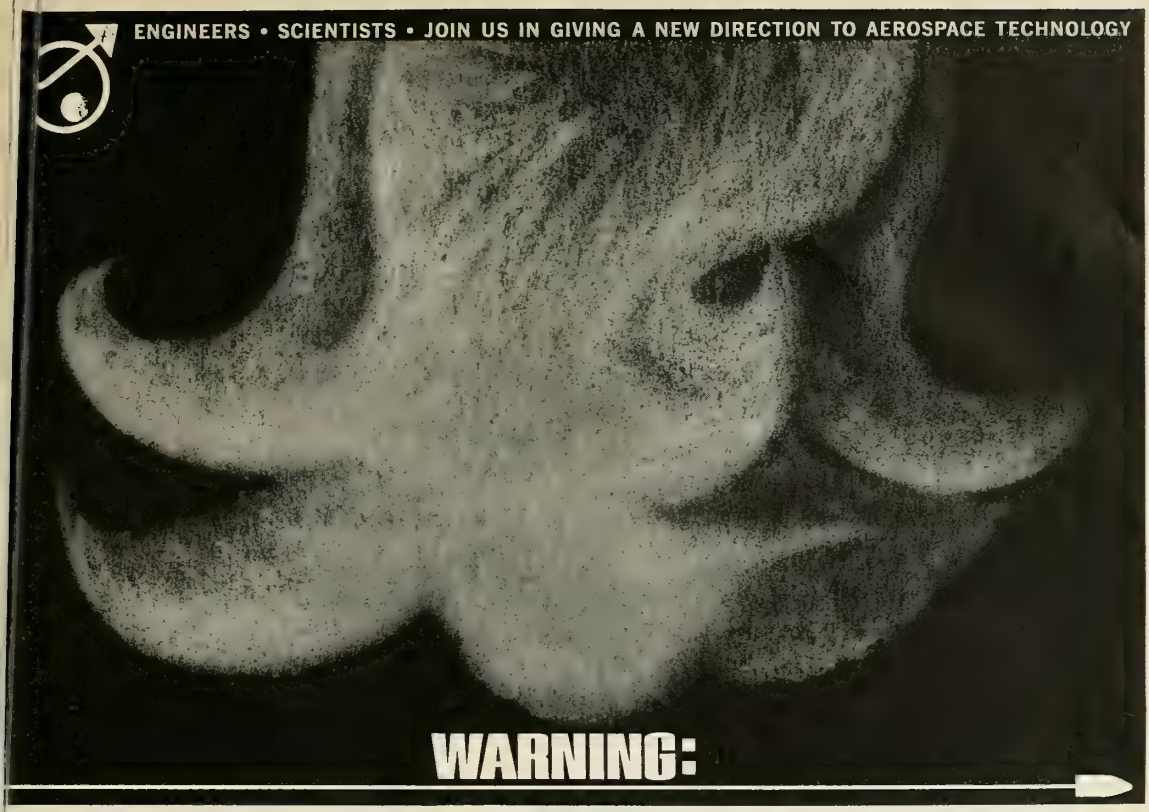
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# Technical Countdown

## ELECTRONICS

### Infrared Guidance System Demonstrated

Martin Co. engineers unveiled their infrared tracker (MIRTRAK) system in Washington, D.C., last week. The system can be used to guide a short-range missile to its target, direct two space vehicles to a rendezvous or to blind-land jets. The system has two parts, a light source and the tracker itself—the latter sensitive to infrared light of a specific, predetermined frequency and capable of automatically calculating the source's location. The experimental unit has no moving parts and has been demonstrated to be accurate within one foot at two miles. An operational model would weigh about 15 lbs. and resemble a portable TV in size.

### Librascope Introduces L-2010 Computer

A high-capacity, general-purpose digital computer with a magnetic-disk memory capacity of 4096 words marks Librascope's latest move in the military tactical market. The solid-state unit weighs 60 lbs., takes up 2 cu. ft. and is intended for severe field situations in target motion analysis, navigation computations, ballistic computations, system simulation and automatic system checkout. The L-2010 can be used as either a self-contained data-processing system or as a unit in a computer complex. The unit can operate efficiently in ground installations, on moving land vehicles and aboard ships.

### Electronic Circuits Through Flash Printing

A flash technique, generating high temperatures for milliseconds to deposit electronic circuits, is under development at Armour Research Foundation. For example, copper oxide can be painted on a circuit board and then covred with a light-reflecting shield containing the circuit pattern. The high-intensity flash releases the copper in the coating; the excess oxide is then removed with a solvent. Resistor elements can be made in a similar manner and multiple-joint soldering is possible with a single flash. The process lends itself to automated production methods, but considerable development effort remains.

### Inflatable Antenna for Ocean Recoveries

Goodyear Aircraft's Arizona Div. has developed an inflatable, transmitter-carrying radio antenna for nose cone recovery at sea. Upon contact with salt water the 2.5-lb. antenna inflates automatically into a cone 9 in. across its base and 12 in. high. A small pointed cone extends another 13 in. from the main cone and contains wire antennas connected to the packaged transmitter. The unit beams a signal capable of reception by aircraft at 30,000-ft. altitude at a distance of 250 miles. The fabric devices were developed for Hughes Aircraft.

### Raytheon Approaches Automated Circuits

A specially designed transfer wiring machine is leading to the automated production of integrated circuits at Raytheon's Missile and Space Div. Electrolytic copper foil is bonded to 0.01-in.-thick Teflon film. Suitable wiring patterns are then etched from this supported foil. In the process, this pattern is transferred as an overlay on a pellet component-loaded substrate. With the application of heat and pressure, the strength of the copper-to-Teflon bond is reduced to permit separation. The pattern is bonded to the B-staged resin-coated substrate and soldered to the pellet contact surfaces. Automation will be achieved by using a sprocket drive and an electronic control loop to accurately register conductors to substrate contour and to pellets.

### Parametric Amplifier Operated at 4.2° K

MIT Lincoln Lab specialists have operated a parametric amplifier in a bath of liquid helium, using a commercially available gallium arsenide varactor diode. The unit has a noise temperature of less than 10° K, comparable to the noise figure of maser amplifiers engineered for systems application. The gain and bandwidth of the amplifier are essentially independent of temperature. The test unit operates at L-band with a $K_u$-band pump. MIT experts see no reason to believe comparable operation cannot be realized at signal frequencies up to 15 kmc and perhaps beyond. Helium-cooled parametric amplifiers may supplant masers in many microwave systems, and open routes to new applications impractical for masers.

## PROPULSION

### Hypergolic Attitude Engine at Honeywell

Minneapolis-Honeywell researchers have come up with a half-pound hypergolic reaction-control engine capable of firing either a single burst or a series of 10 per second. Each single burst lasts 500 millionths of a second, and the unit is rated at 50-lbs. thrust. A hydrazine-type fuel and nitrogen tetroxide converge in the tiny combustion chamber, and the flow ceases at the instant of explosion. The detonation combustion engine reaches a chamber pressure of 5000 psi with tank pressure of only 5 psi.

### First Long-Duration J-2 Firing Successful

The liquid-oxygen/hydrogen J-2 engine ran for four minutes at full thrust in its first long-duration test run at Rocketdyne's Propulsion Field Lab near Canoga Park, Calif. The engine, destined for upper-stage use in the *Saturn* vehicle, generates less than 150,000-lbs.-thrust at sea level, but this equals more than 200,000 lbs. at its operating altitude.

## ADVANCED MATERIALS

### Stress Corrosion-Resistant Aluminum Perfected

A proprietary process developed by Harvey Aluminum eliminates stress corrosion in high-strength aluminum alloys. The stress problem has often meant substituting a lower-strength aluminum alloy in design applications, thus sacrificing strength and efficiency. The Harvey alloy withstands sustained surface tensile forces equal to 75% of the longitudinal yield in any direction, including short transverse, without developing stress corrosion. The alloy can be substituted directly for 7075-T6 without design modification. Assigned a temporary designation of —T75, the material is available in die forgings, rod and bar, and extruded shapes.

### Linde Producing Liquid Helium

Liquid helium is being produced at the rate of 100 liters per hour in a small plant built by Linde Co. near Amarillo, Tex. The gas is brought to the facility from U.S. Government helium plants and run through a relatively uncomplicated process cycle contained within a large, vacuum-insulated vessel. A second such system built by the firm is in operation at NASA's Lewis Research Center. Another production facility is under construction. Linde delivers the liquid helium all over the country in special, non-nitrogen-shielded containers with loss rates of 0.1 Btu per hour.

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# Metal-Elastic Wheels Studied For Lunar Locomotion

***Grumman pushing design; cites load-carrying and vehicle dynamics advantages in 'poor soil'***

**by Michael Getler**

BETHPAGE, L.I., N.Y.—A uniquely designed "metalastic" wheel may play a key role in lunar surface locomotion for either *Apollo* crews or unmanned remotely controlled Moon rover vehicles.

During a three-year development program here, Grumman Aircraft Corp. has evolved three Moon-wheel configurations. One, in particular, is being focused upon for the early lunar mission. It uses a series of spiraling flexible spokes emanating from a single central hub to support the wheel's elastic rim.

The combination, according to Grumman engineers, yields a totally elastic system—one in which the entire wheel structure supports applied loads and driving torques. The wheel is aluminum, with the central hub designed to house individual motor and transmission equipment. The drive components are now undergoing separate vacuum tests.

The wheel is designed to operate on surfaces like those specified for Jet Propulsion Laboratory's lunar model—since adopted by NASA for *Apollo* design specs—and also on terrain similar to that recently advocated by Russian astronomers.

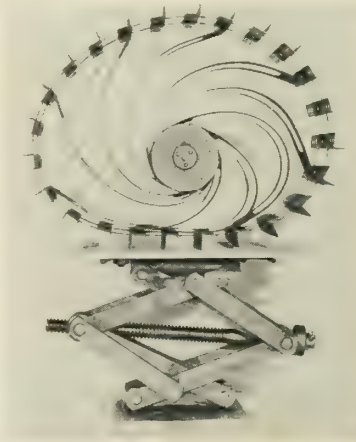
JPL envisions the surface as a shallow dust layer covering a hard stratum. The Soviets regard a sintered or rock froth surface texture as most probable. In their present form the wheels would not be suitable for the deep unconsolidated dust supposed by the lunar surface theory espoused by Thomas Gold of Cornell University

Under load or torque, the wheel takes on elliptical shape. This gives it characteristics which Grumman engineers feel make it especially adaptable to the high-probability lunar surface operation.

• **Long footprint**—In operation the wheel appoaches the long "footprint"—or ground contact advantage—of a track vehicle, while retaining the weight and mechanical friction advantages inherent in a simple central hub design. When the load is increased, thus enlarging the footprint, Grumman reports, there is virtually no increase in overall footprint unit pressures on the surface. Therefore, they claim, the elastic wheel offers the load-carrying ability and dynamic stability of a rigid wheel several times its size—at the same time improving mobility in poor soil with minimum energy loss.

Edward Markow, project engineer with Grumman's Space Science Group and chief designer of the new devices, says that the metalastic wheel, in comparison with a rigid wheel of equal diameter, provides a 50% decrease in roll resistance, an increase of about 40% in draw-bar pull, and—especially important to lunar locomotion—impressive ability to climb obstacles.

With a flexible system, says Markow, there is no serious design penalty in hitting small obstacles. Impact loads go far down, giving the system designer considerable freedom to concentrate on static rather than impact loading problems. A supple wheel form, he points out, does not rebound, but, with a drive force applied, will actually climb the obstacle by translating the compression and rotational energy.



*'METALASTIC' wheel, loaded and configured with space-links, displays long footprint advantage of track vehicle. Wheel can also be configured with solid outer rim.*

In tests, the flexible wheel reportedly demonstrated its ability to climb obstacles ¾ the size of the wheel's relaxed diameter. A rigid wheel is said to be able to normally climb to ⅓ its height. In keeping within the lunar model, the vehicle is designed to climb obstacles of at least 10 cm, and be capable of maneuvering around anything larger.

Markow notes that the wheel also supplies increased fatigue life and more predictable behavior attributable to metals in a space environment. Further, he says, it poses fewer temperature-range problems than do pneumatic systems—particularly important in terms of lunar day/night extremes—and provides resistance to puncture by a craggy surface or other lunar debris.

Early laboratory and soil bin tests of the new wheel were successful enough so that the firm funded a longer-range development and test program. This has carried the project to New York's Fire Island, where a group of engineers is now observing and photographing a 1/6-scale simulated lunar vehicle towed over sand and rock beaches.

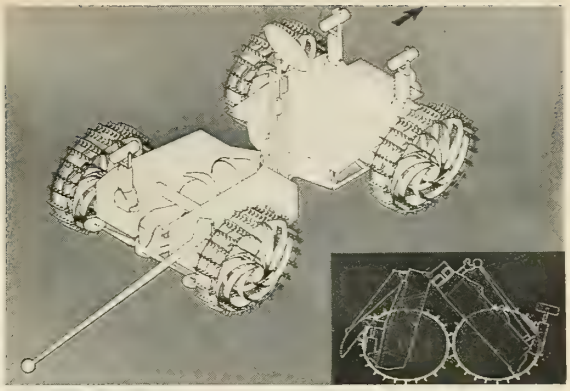
Markow reports that tests have added to the enthusiasm for the design concept. The film is being shot at six times normal speed, with real-time playback providing a simulation of lunar-vehicle dynamics.

• **Dynamic problem** — Markow points out that in designing for lunar operation, vehicle dynamics, not load-carrying ability, appears to have the most pronounced effect on mobility. A turning maneuver has to contend with the same centrifugal forces as exist on Earth, but with only 1/6 the stability force available.

As an example of design problems, Markow reports that a 3000-lb. vehicle making a 20-ft. radius turn at 10 mph would require a 16-ft. vehicle width to prevent overturning. Contacting a 4-in. bump at the same speed would cause



*SMALL-SCALE lunar rover is now being towed over sand and rock beaches to test vehicle dynamics in poor soil.*



*ORIGINAL GRUMMAN conception of basic Prospector-type lunar vehicle with space-linked metalastic wheels.*

the vehicle to leave the surface for about 20 ft.

Tests at Grumman demonstrated that to reduce dynamic loads on a wheel it is more advantageous to decrease wheel stiffness than to decrease the suspension stiffness. Order-of-magnitude variations are required in the suspension stiffness to significantly affect dynamic loads.

Initially, Grumman intended to propose the metalastic wheel to NASA for use with a 3000-lb. *Prospector* vehicle. But then as *Prospector* faded as a program, the firm continued in-house development of the wheel along with a continuing major effort in the entire realm of lunar logistics support. It felt certain that some form of roving lunar vehicle would be required.

In pursuing this effort, Grumman has marshalled lunar-soil mechanics studies, provided shelter-base support and landing vehicle data support, and developed a remotely controlled lunar jeep, now roving the runways at Bethpage in trial runs.

• **Smaller vehicle**—The design now being concentrated on here is a 1500-lb. four-wheel-drive lunar vehicle, adaptable to the "building block" or multi-vehicle train concept, which may be closer to the requirements for *Apollo* support. To support the 12 x 16-ft. chassis (weighing about 1200 lbs., including the wheels plus another 200-300 lbs. of life support equipment), four metalastic wheels 5-6 ft. in diameter, 10-12 in. wide, each weighing about 100 lbs. would be used.

Due to a low unspring weight—about 30% of a total wheel weight—the elastic wheel will, according to Grumman, yield about a 60% reduction in dynamic loading as compared with a rigid wheel and its suspension system. The sprung-to-unsprung weight ratio for the entire vehicle is 20:1. Spring rates for elastic wheels are said to be between 20-100 lbs. per inch of hub deflection below the horizontal, compared to rates between 1000-5000 lbs./in. for standard rigid wheels.

The Grumman design also uses a canted wheel suspension system providing inherent skuff damping action much the same as that used in several light aircraft landing systems.

To increase gross traction and reduce slip rates—a factor which could be extremely important in navigating much of the sloping lunar surface—Markow reports significant gains were made by adding "space-links" to the outer rim.

Gross traction developed by ground failure with the space-links was some 60% greater than with space-linked rigid wheels on a loose soil surface. With a partially sintered surface, Markow claims, gross traction would double. Engineers also relate that in tests of roll resistance using a chemical foam to simulate the rock froth surface, data showed a dwell time or velocity factor, with respect to soil failure beneath a vehicle, is present.

• **Second-generation type**—The latest addition to Grumman's line of metalastic Moon wheels is an elliptical wheel whose elastic rim is supported by a series of flexible fixed length spokes, the geometry of which is controlled by two canted and opposed hubs. Thus the net effect is an elastic wheel in which the major axis is always maintained in the horizontal.

Grumman reports the total weight of this wheel for a given design load is less than with the other metalastic wheels, since a higher percentage of the wheel structure is stabilized by tensile elements. As a result, the wheel is reported to have extremely good load-carrying capabilities (about twice that of the spiraling spoke design) and low roll resistance in relation to its somewhat smaller footprint. However, the wheel is more susceptible to impact loads—and hence less desirable on a bumpy lunar surface.

The wheel is viewed as a possible second-generation device pending more information on exact make-up of the lunar surface. There have also been expressions of interest by the Army for terrestrial applications.

Though Markow is extremely optimistic over the metalastic design, he emphasizes that at present the wheel represents just a design approach rather than a finite design. Many of the basic Grumman wheel studies were based on locomotion studies accomplished by the Army's Land Locomotion Laboratory in Detroit.

Grumman currently holds one of two three-month lunar logistics multiple-payload studies let by NASA; Northrop Corp. holds the other. These awards, together with another contract held by STL on a lunar "bus" design study and NASA's own extensive in-house effort, are expected to provide the base for whatever development and hardware plans the space agency embarks upon.

First new action in this area is expected early next year: NASA design goals indicate that some of the logistic payload, in particular the roving lunar vehicle, should be available in mid-1965. ⁂



*CANTED HUB on elliptical wheel has high load-carrying capability but shows more susceptibility to impact loading.*

# NASA Has New Bioastronautics Unit

***Office of Advanced Research and Technology has long-term man-in-space planning function***

**by Heather M. David**

A NEW OFFICE at NASA has begun letting contracts in the bioastronautics field.

Set up two months ago, the Office of Advanced Research and Technology has the awesome task of planning for man in space for the next 20 years.

Among the types of research the office will do are:

—Specific experiments on manned spaceflights (such as *Gemini, Apollo* or any future manned space laboratory).

—Animal satellites, including those possibly originated with OART or in cooperation with other NASA offices.

—Hitchhiker or piggyback experiments on existing missile and rocket flights when space is available. These experiments can be contained in pods or nose cones and in most cases can be made recoverable.

—Simulator studies, which may entail building of new devices and new bioinstrumentation.

—Laboratory studies—basic studies carried out mostly by universities or research institutions.

Budget is now being worked out. Dr. Eugene Konecci, director of OART, said the figure will be "adequate for our programs this year, and will increase as our task grows."

Dr. Konecci's master plan—shown on a chart that stretches around his office—is to do complete enough bioastronautics research so that it will never have to be done again.

This, he hopes, will eliminate any duplication of effort, a problem which has stirred congressional attacks on the services and NASA in the past.

The office's approach will be one of systems engineering. The integration of man into future spacecraft will be at the base of all the office's bioastronautical research.

All human-factors work for future NASA vehicles, including their ground handling, is also the office's responsibility.

• **Types of contracts**—Both grants and contracts will be awarded by OART. The office will be open to unsolicited contracts if the proposal fits in with the program's needs.

Research the office will support



DR. KONECCI

covers the whole gamut of man-in-space: intensive study of the human psychophysiological responses, the engineering of life-support systems, and the development of human factors engineering techniques to integrate man into the spacecraft.

"We will work with anyone who has the capability," Dr. Konecci told M/R. "This may be NASA centers, Department of Defense, industry, research organizations or universities."

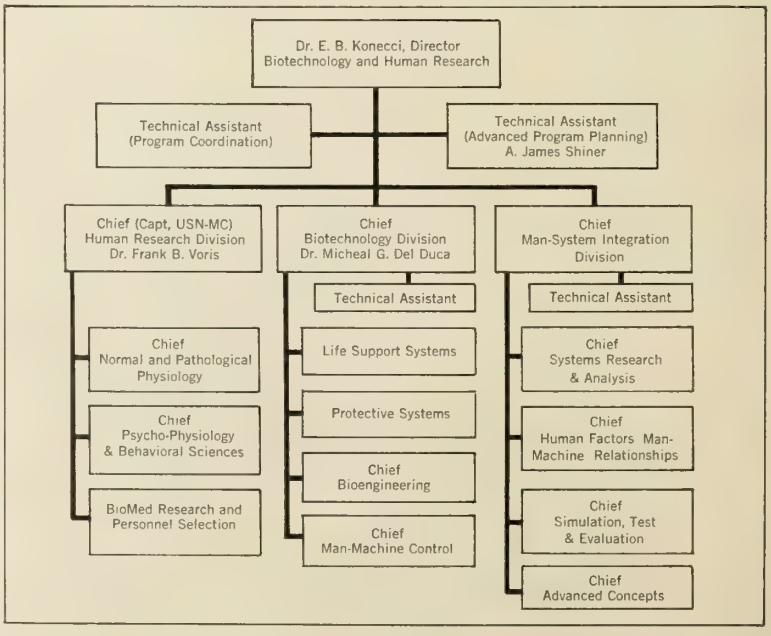
In the next six months, Dr. Konecci said, he will probably be looking for:

—Work in advanced life-support systems, especially in 30 and 100-day systems—chemical or physical—that meet with reliability, safety, weight and power requirements.

—Advanced bioinstrumentation, including biomedical sensors and psychophysiological monitoring techniques.

A number of contracts have been "inherited" or renewed from the old life sciences office of NASA. One of these just renewed is a study of cyborgs by United Aircraft Corp. This study will seek ways to extend man's capabilities to withstand extreme stresses or perform beyond his normal limits through mechanical, physical or pharmaceutical means.

Other work particularly desirable, according to Dr. Konecci, is research



into the effects on man of radio waves, microwaves and visible rays.

Particular attention will be paid to development of new instrumentation for more accurate and detailed information from simulators as well as space capsules. Dr. Konecci said "We need right now to identify what parameters are meaningful and what equipment is necessary."

• **Hardware** — prototype hardware will be built where necessary both to insure design reliability and to conduct additional experiments.

"We have to keep continually ahead of the game," says Dr. Konecci. "Our work must be done before the specs are written. Once it becomes a project, it goes to the Office of Manned Spaceflight.

Missions will be divided into those of 14 to 30 days, 30 to 100 days, 100 days to 6 months, 6 months to a year and those more than a year. This timetable will conceivably cover all spaceflights possible in the next 20 years.

• **Staff** — Dr. Konecci's staff, now being hired, will have about 18 professionals. All will have medical degrees or engineering degrees with experience in life sciences.

The office has close liaison with DOD, and it often meets with other NASA bioastronautics and program offices to prevent duplication, says Dr. Konecci.

One feature that sets this office aside from all others at NASA is that it is the only one dealing with aeronautical and space research at once. Dr. Konecci points out that for life support, many space problems must be faced in supersonic flight in the atmosphere.

The office expects that much of its research will be of immediate benefit to the Earth-bound scientific world. Dr. Konecci points out that bioinstruments can be used by researchers in various fields of medicine and biology. Protective devices or systems, he says, will be used for hazardous ground-based activities, such as fire fighting.

Life-support equipment will have uses in hospitals, operating rooms, or industrial clean rooms.

Simulation techniques, he said, will give knowledge to devise appropriate training programs for aircraft and space systems. And knowledge will be gleaned for the exotic sciences such as cybernetics and bionics.

Dr. Konecci was formely chief of life sciences for Douglas Aircraft's Missiles and Space Systems Div. He was chairman of the American Rocket Society's Bioastronautics Committee, executive secretary of the International Astronautics Federation's Life Sciences Committee and a vice president of the Aerospace Medical Assn. ⁂

space electronics

# Radio Interference Problems To Worsen

INTERFERENCE PROBLEMS created by the innumerable radio frequency emitters in use today are expected to worsen steadily.

The situation is intensified by the current trend toward increasing signal densities and strengths, by the rapidly expanding space programs and by the growing electronic capabilities of foreign countries.

Radio interference, in simple terms, is any signal that reduces accuracy or reliability of reception. Interference and its effects are somewhat self-perpetuating —as interference is experienced, transmitter on-time is increased together with power. Both of these actions increase interference, which in turn causes further increases in transmitting power and time. Even though this is an oversimplification, it illustrates one aspect of the problem.

RFI is no longer just a nuisance, a Genistron, Inc., spokesman told M/R recently. This is a costly and sometimes deadly problem which must be of major concern to all electronics users.

• **ECAC in operation** — The RFI field defies definition because of its immense complexity. For this reason a single Defense Department agency is attempting to use mathematical analyses and simulation techniques to predict interference problems and perfect methods to reduce them.

The Electromagnetic Compatibility Analysis Center (M/R, Dec. 4, 1961, p. 27), operated by the Armour Research Foundation for Air Force Systems Command is just beginning to tackle the RFI problem with involved studies into spectrum signatures and listings of all military transmitters.

ECAC performs as a consultant and advisor to DOD, to individual military services and to industrial designers. Initial input data covering signatures and environmental information will be concerned primarily with military radar systems. Communications problems will have to be shelved for the time being, according to ECAC officials.

Individual equipment will be studied by outside contractors to each of the military services to determine electronic operating characteristics. The center will then employ these data inputs to determine environmental interaction, frequency allocation information, operational procedures and possible interference and susceptibility-reduction measures for offending equipment.

The major threat in RFI, according to one industry spokesman, is its capability to limit electronic systems utilization. This will have the effect of slowing major programs or stretching out system procurements, since no agency will fight for funding to purchase items that cannot be used.

Two theses are appearing in electronic systems design:

—Susceptibility to and generation of RFI must be considered when missions are assigned and equipment is being designed.

—Interference problems do not always respond to a general solution.

Industry sources point out that the current great concern for component reliability has not been fully matched by efforts directed toward over-all reliability under exposure to interference.

System failure under interference conditions can be more serious than some component failures. A total failure can often be found and remedied, or even bypassed—but degradation under interference is more difficult to recognize and is easily misinterpreted.

Modification alone of existing systems will not correct RFI problems. New designs are required. For example, at an IRE symposium in San Francisco last June, one expert pointed out some current efforts in this field. In higher frequency antennas, such approaches as improving gain with respect to desired direction and reducing gain for all others can be employed. Signal suppression by sidelobe blanking or by phasing has been employed.

Capehart Corp. engineers report they have successfully turned to the use of computer techniques to assist in RFI design problems, particularly when equipment must be built to function in areas exposed to a higher-than-average number of RF emitters.

Attention to interference modes and methods of interference reduction are mandatory now and will soon become urgent. Some traffic will eventually be diverted to relatively uncrowded spectral areas as laser techniques improve, but industry leaders say this will not provide significant relief. ⁂

*Award-winning paper . . .*

# Nuclear Fusion Propulsion Concept Appears Feasible

***Three recent achievements could speed development of a reactor***

**by William I. Linlor and Milton U. Clauser**

DEVELOPMENT OF a successful fusion plasma propulsion system may require a national effort of considerable scope. Is it worth it?

Seeking to answer this question in a brief paper, we can consider only a few of the system's chief characteristics. Two of these are specific impulse and thrust-to-mass ratio.

In any *new* system, these ought to be significantly greater than they are in alternative systems — greater, for example, than would be achieved in electric propulsion coupled with a fission power plant. The characteristics of the fusion reactor must be exploited in such a way as to make the propulsion system capable of an acceleration of at least 1 G, together with a specific impulse of at least several thousand seconds.

Later in this paper we shall explore the possibilities of an arrangement that may provide these characteristics.

Is such a system *needed?*

Often in history the simple fact that a capability exists creates a mission need. The fission and fusion weapons are recent examples.

More specifically, within the next few years—or possibly the next few months—we shall learn whether a planet like Mars or Mercury is inhabitable. If the answer is affirmative, it seems evident that our national interests will demand development of a high-acceleration, high-specific-impulse system suitable for interplanetary traffic.

• **Three steps forward** — Will a fusion reactor become available? If so, when?

In recent years the onrush of scientific achievement has produced three outstanding developments which bear on the fusion problem, and give added importance to the role of fusion power in space propulsion.

The first of these is the discovery of superconductivity at high magnetic fields. This might make possible, if fusion plasmas were stable, the design of a net power-producing fusion reactor that could fit into a scientist's office, instead of requiring two football fields placed end to end. Equally important, the weight of such reactor might be reasonably small.

Another noteworthy achievement, with which are associated the names of Dr. Theodore Maiman and the Hughes Research Laboratory, is the development of the laser.

As we shall see later, the availability of high-intensity photon sources, characteristically in the range of several kilowatts per $cm^2$, would make it practical to trap fusion plasma in magnetic containers employing photoelectric dissociation.

The third major achievement of recent years carrying important implications in fusion research is cryogenic pumping. It is well known that the presence of residual gas in a fusion reactor is a serious impediment to the accumulation of plasma particles. Charge exchange, energy degradation, and similar reactions can quickly remove the plasma or quench its energy. To keep losses at a sufficiently low level, a vacuum of about $10^{-9}$ mm Hg is desirable, with pumping speeds in the range of 100,000 liters per second. Cryogenic pumping offers these capabilities. At Hughes, Sig Hansen has such a system in operation. By a fortunate coincidence, cryogenic vacuum pumping and superconductivity employ similar engineering techniques.

• **Where we stand** — Consider the status of fusion research. In Fig. 1, taken from the book, "Project Sherwood," by Dr. Amasa Bishop, the steady-state operating conditions of a fusion plasma can be characterized by the following orders of magnitude: Density, $10^{15}$ particles per $cm^3$; ion energies, $10^5$ electron volts; contain-

## Ion Engine Launchings Due

CINCINNATI—Research on ion engines is nearly completed and ready to be reduced to practice. The look ahead is at nuclear fusion and fission propulsion concepts.

These were the major points brought out Oct. 2-4 at the Third Symposium on Advanced Propulsion Concepts. Sponsored by the Air Force Office of Scientific Research and General Electric's Flight Propulsion Div., the symposium was attended by more than 600 leading propulsion engineers and scientists.

• **Engine launches set**—Three battery-powered ion engines are scheduled for launching by NASA and the Air Force within the next eight months, said Dr. J. C. Evvard, Lewis Research Center official.

NASA will launch two ion engines on a *Scout* sometime next spring, he said. One will be a cesium-contact ionization engine publicly disclosed earlier this year by Hughes Aircraft; and the other, an electron-bombardment engine devised by Lewis engineer Harold Kaufman.

An Electro-Optical Systems, Inc. ion engine also working on the cesium-contact principle is scheduled to ride on an AF *Blue Scout* by next month.

Main reason for the tests is to see if ejected ion beams can be neutralized under space conditions. The beams must ultimately be converted to neutral plasmas if the ionic drive is to yield thrust.

The Lewis test will also measure the radio waves associated with the ejected beam to see if the plasma generates signals that can be picked up on the ground or in space. One result could be radio interference or undesirable ionic-drive signatures.

ment time, about one second to obtain a reasonable burnup of fusion fuel.

Use of ions from an accelerator to produce a fusion plasma is exemplified not only by the Oak Ridge DCX Project, but also by the Livermore Waldo Project and the "OGRA" machine of the USSR.

It would be helpful to pinpoint the progress of the various approaches toward steady-state operating conditions, and to evaluate the prospects for eventual success. Such appraisals are necessarily subjective in nature, however, and may quickly lead to fretful arguments. At the 1961 Salzburg Conference, all of the approaches reported had difficulties with plasma instabilities; plasmas were contained for about 100 microseconds at most. If the reactor is to produce net energy, an increase in containment time by a factor of $10^4$ is necessary; this may seem discouraging to some investigators.

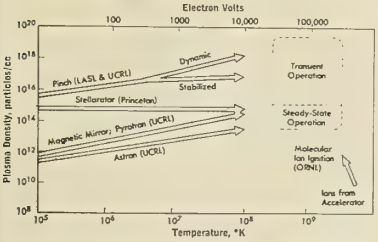



*Fig. 1—Status of fusion research according to Dr. Amasa Bishop.*

The nature of plasma instability is extremely complex—indeed, there may be *many* instabilities operating simultaneously, exhibiting pinching and wriggling of plasma, drift to the walls, or rapid loss of plasma particles across lines of magnetic flux. In addition, rotation of the plasma has been observed for each configuration. On the theoretical side, analyses of plasma behavior are almost unanimously unfavorable; they predict instabilities of many sorts any one of which can be fatal.

This evaluation is realistic, but perhaps pessimistic. An optimist might point out that independent research teams agree on the nature of the plasma difficulties, and this suggests that the techniques and diagnostics are fairly well developed. He would certainly note that in the DCX experiment at Oak Ridge, containment of a plasma has been observed for many seconds when the plasma density is of the order of $10^7$ particles per $cm^3$.

• **Plasma production** — If density can be increased in a controlled and systematic way, will the instabilities evolve in a gradual way, thus allowing identification of their nature? To answer this, we need adequate control of the plasma density, at high energy. Thus we come to the problem of producing a fusion plasma, employing high-energy injection. This requires a means of trapping the ions within the magnetic field by a sufficiently irreversible process.

## Award-winning Paper

This paper by two scientists from Hughes Research Laboratories was chosen by a panel of Air Force Office of Scientific Research scientists for the MISSILES AND ROCKETS first prize at the Cincinnati symposium. Condensed here for publication, it will be printed in its entirety by General Electric in the proceedings.

Runners-up: "Impulsive MHD Devices as Space Engines," by R. H. Lovberg, General Dynamics/Astronautics and "Quest for Heavy-Particle Electric Propulsion," by R. E. Hunter, ASD, Wright-Patterson AFB.

It is almost trivial to say that if an energetic molecular ion is broken up into an ion and a neutral particle, while within a magnetic field, then the energetic ion is trapped. The subtle and difficult problem arises when one tries to specify the nature of the agent that produces the dissociation.

In the case of OGRA, the molecular ions are dissociated on the residual neutral gas, which is present even under high-vacuum conditions. This process has several difficulties. Under typical conditions, only one ion out of every million injected is trapped.

Furthermore, the neutral gas causes serious loss of the trapped ions by charge-exchange reactions. The limiting value of plasma density obtained in this way is far too low to be of fusion interest. In the case of DCX, auxiliary trapping agents such as the carbon arc have been employed to produce considerable trapping; however, the arc has a correspondingly high loss characteristic, so that the net effect is not much different from that of residual gas. At present, use of carbon arcs has been abandoned in the DCX work, and trapping on residual gas is employed, even though this has limited usefulness.

It would be highly desirable to find a method of dissociating molecular ions using a lossless medium. For many years we have been studying two methods of dissociation which have the desired "lossless" characteristic. One is electric field dissociation, the other is photoelecetric dissociation.

Use of visible light to dissociate high-energy molecular ions was proposed and the cross-section was measured about six years ago. Implementation of this process as a practical method of plasma production is dependent on the development of high-intensity photon sources. As previously mentioned, such irradiation sources are under active development, in connection with optical pumping of lasers.

Fig. 2 shows the photodissociation process, and Fig. 3 shows schematically a possible arrangement. To obtain sufficiently intense irradiation in a reactor, an array of photon sources may be necessary; this might utilize reflecting surfaces. Fig. 4 shows the transitions involved in photodissociation of $H_2^+$ molecular ions. The effectiveness of this process is indicated in Table 1. If an intensity of one kilowatt per $cm^2$ can be achieved, the corresponding mean life of a hydrogen molecular ion is about 100 microseconds.

This mean life is about equal to the "free-flight time" of a charged particle in a mirror-machine or stellarator of reasonable size. Thus, an injected ion spends about 100 microseconds within the machine from the instant it leaves the injector until the instant it returns to strike the injector. During this 100 microseconds about half of the injected molecular ions would be dissociated and therefore trapped by the action of the photon flux having an intensity of 1 kilowatt per $cm^2$.

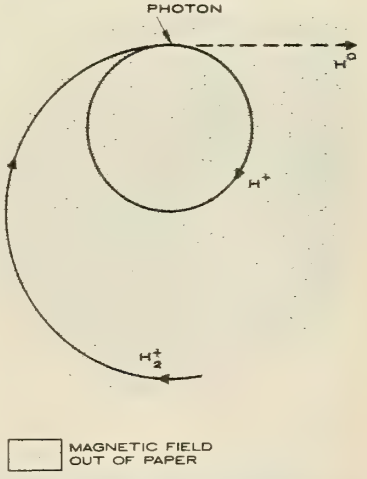



*Fig. 2—Sketch of photodissociation process shows photon impacting molecular ion.*

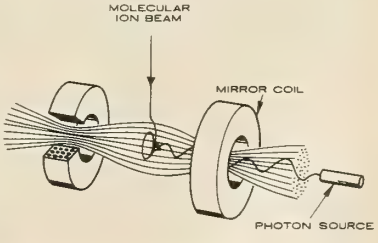



*Fig. 3—Schematic of possible arrangement of photon source and ion beam.*

For such a high dissociation fraction, this method of plasma production looks quite promising. As mentioned earlier, if one can regulate the plasma density at high energy, so as to enter the instability regime under controlled conditions, such experimental probing may be expected to yield useful information about the details of the instabilities; when the causes are clearly understood, one may determine what to do to prevent their onset.

• **Conceptual design**—Many engineering problems must be analyzed before a design can be regarded as feasible. We will try to obtain only order-of-magnitude estimates of the performance and weight of basic components.

Consider the problem of heat disposal. A fusion reactor must emit radiations such as neutrons and bremsstrahlung, which are intercepted by the solid portions of the vehicle and thereby transformed into heat.

This "heat power" may be a significant part of the total fusion power. If it is to be radiated away, the radiators may require about one kilogram per kilowatt. Such a configuration would have a maximum acceleration of the order of 0.001 G, if the specific impulse is in the range of several thousand seconds, and thus have performance roughly comparable to currently conceived electrical propulsion systems.

An admittedly bold approach, which raises many important and difficult technological questions, is the use of a coolant to eliminate the need for radiators. A coolant such as lithium would absorb the "heat power" by an increase in enthalpy without exceeding a temperature that is safe for structural material. After absorbing the heat power, the coolant would change its role and become the propellant.

It receives power directly from the fusion plasma and is thereby heated to exhaust temperature. A suitable ejection nozzle system produces the desired thrust. A schematic arrangement of the lithium and fusion plasma is indicated in Fig. 5.

This shows a stellarator-type configuration, in which the fusion plasma occupies a cylindrical volume along the axis. Surrounding the plasma is a cylindrical shell containing the ionized lithium. Although the entire reactor is not shown, one can readily visualize the introduction of the lithium vapor at any convenient location, whereupon it becomes ionized by the radiations from the fusion plasma, and is therefore confined in the radial direction by the magnetic field.

The lithium plasma is free to move along the field lines until it reaches the divertor region shown in the sketch,

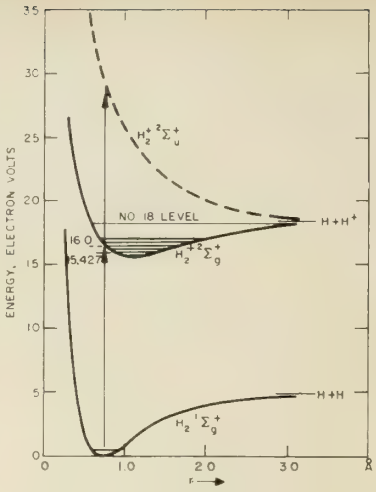



*Fig. 4—Atomic transitions involved in photodissociation of molecular $H_2^+$ ion.*

where it is expelled from the lines of force by centrifugal forces and by the magnetic field gradient of the nozzle coils. (Arrangements other than the one shown are of course possible.) Experimental information is needed for this phase of the operations.

To ensure that the fusion plasma is not mixed with the lithium plasma, appropriate rotation of the lithium may be necessary.

Basically the lithium plasma must surround the fusion plasma because of the high rate of cyclotron radiation. As we shall see shortly, for our assumed case of magnetic field intensity and electron temperature, nearly all of the fusion power is radiated in the cyclotron mode. This is a convenient method of transferring the fusion power to the lithium plasma. Products of the fusion process are assumed to be removed from the reactor by the divertor action, in the manner contemplated for a

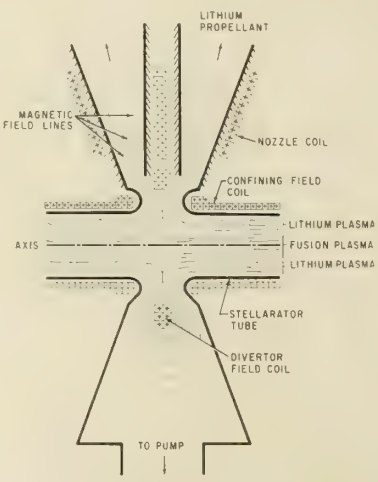



*Fig. 5—Ejection nozzle system showing lithium and fusion plasmas*

standard stellarator.

• **System details** — Choice of fuel and operating temperature is largely dictated by the necessity for minimizing neutron production. Thus the deuterium-tritium reaction, which produces a neutron for each fusion event, is undesirable. Quite obviously the choice of fuel is deuterium and helium, the latter being the isotope of mass three.

Table 2 shows the reaction in equation 1, for which no neutrons are produced. Of course, "side reactions" between deuterium ions can occur, as shown in equations 2 and 3. Of these, only reaction 2 produces neutrons. To minimize this reaction, compared to reaction 1, we select the reaction temperature of 100 kilovolts, with a 50-50 mixture of D and $He^3$. For these reactor conditions, the neutron power is about 2% of the fusion power.

In addition to the neutrons, two sources of radiation from the fusion reaction zone need to be considered; these are the bremsstrahlung and cyclotron radiation. Much of the bremsstrahlung radiation power is produced in the wavelength region of less than an angstrom, and hence cannot be reflected or absorbed in a thin wall.

Conservatively, we assume that all of the bremsstrahlung radiation and all of the neutron power escape from the reaction zone and produce heating in the structural portion of the vehicle. The cyclotron radiation will be mainly in the visible and infrared wavelengths, and hence can be reflected by polished metallic surfaces if desired, with only 1% absorption. It can be readily absorbed by the lithium plasma.

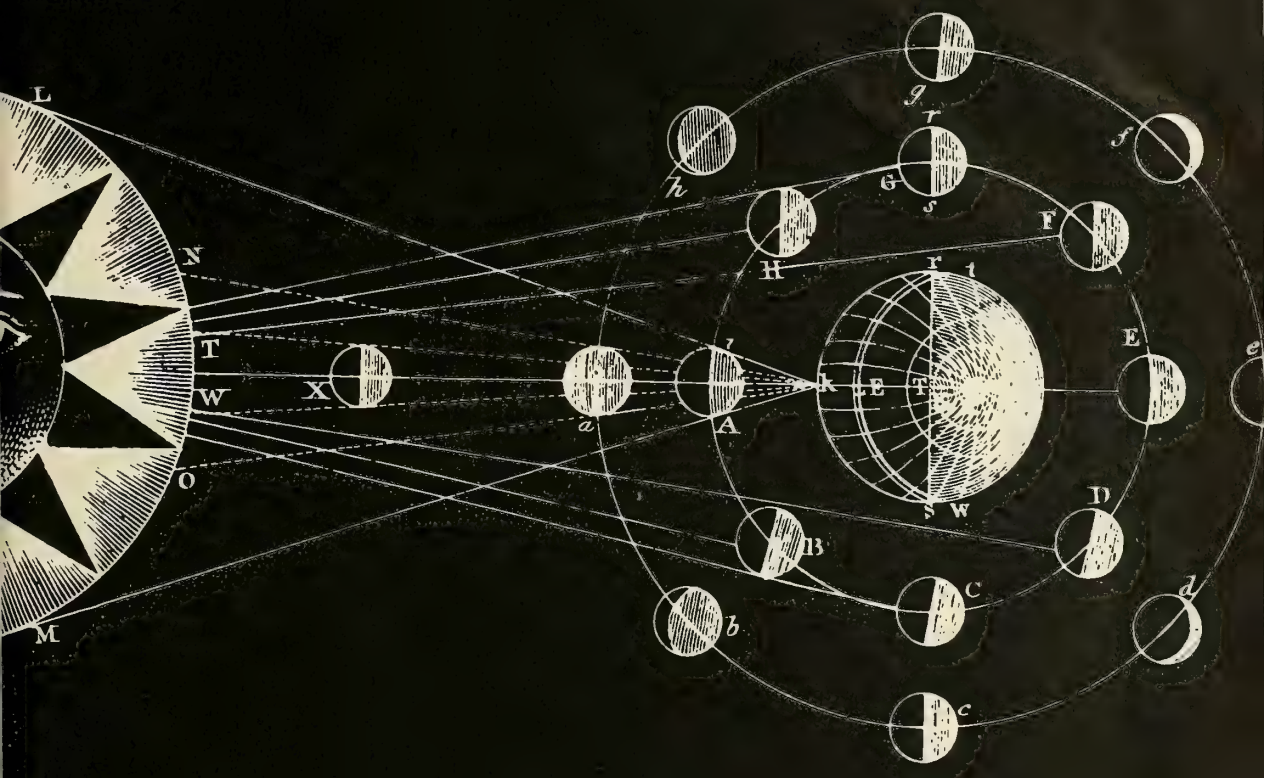
Fuel is fed into the reactor in the cold, neutral state and heated in place; the calculated steady-state temperature of the electrons is considerably lower than that of the D and $He^3$ ions.

The size of the reactor and the weight of many of the components will be determined by the power density, which varies as the fourth power of the magnetic field strength. We assume that during the next few years experience will make it possible to obtain large superconducting solenoids capable of sustaining 400,000 gauss, with current density of $10^5$ amperes/$cm^2$. Experimental samples have already been obtained which exhibit superconductivity at 500,000 gauss.

We further assume that fusion plasma can be contained at a ratio of particle energy density to magnetic field energy density, equal to one-half.

Reactor conditions and power densities are summarized in Table 2. It shows that for the selected conditions, the neutron power is about 2% of the fusion power, and the bremsstrahlung radiation is about 10% of the fusion

The Sun, Earth, and phases of the Moon
— from a 17th century engraving



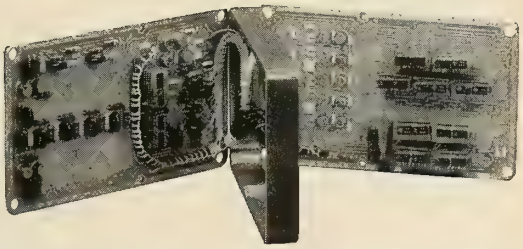

# IEW DIMENSIONS IN SPACE

rom early theories on space geometry, man's knowledge ·ogressed to a finer appreciation of the universe and the ıallenging problems in its exploration.

exas Instruments is applying its capabilities to an im-)rtant part of the challenge — the problems of data :quisition, transmission, recovery, and display.

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)r more information write Marketing department—47.



**Here is one example:** This seven-ounce PCM digital data signal conditioner has the semiconductor network equivalent of 2,215 components. Logic is performed by *Solid Circuit** semiconductor networks — 102 of them. This equipment has already been delivered to the Department of Physics and Astronomy at the State University of Iowa for an EGO satellite experiment.

** Trademark of Texas Instruments Incorporated*

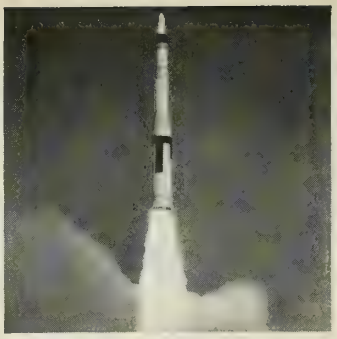
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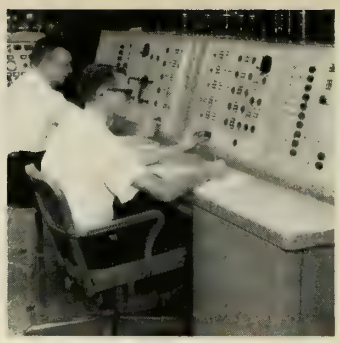
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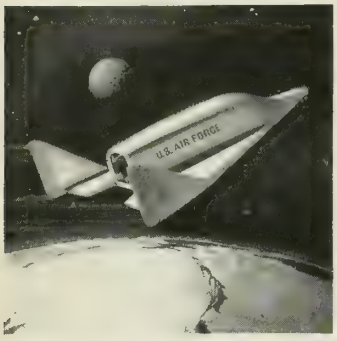
Weapon system management: BOMARC



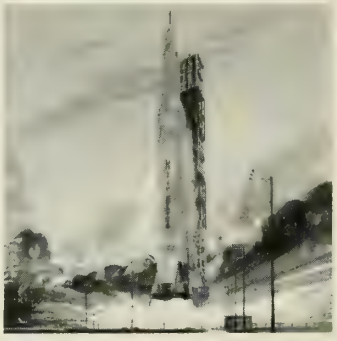
System integration: MINUTEMAN



Electronics engineering and manufacture




System contractor: DYNA-SOAR



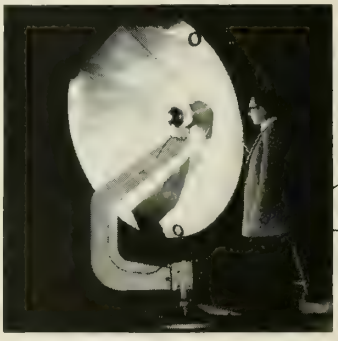
Space booster development: SATURN S-IC



HYDROFOIL development, construction



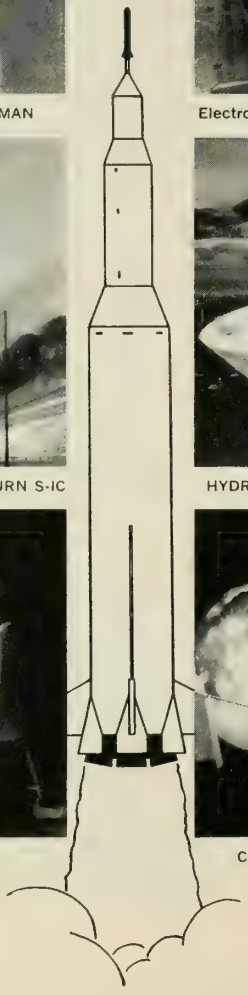
Space medicine research



Satellite control research



Counter-moon research vehicle



## Management for today and tomorrow—by Boeing Aero-Space Division

Boeing's Aero-Space Division has major contract responsibilities in the fields of missiles, weapon systems, boosters, space vehicles, electronics, hydrofoils and space research.

The Division is backed by the most extensive laboratories and research facilities in the industry, and employs advanced business systems and management techniques such as PERT. Fifteen thousand engineers, scientists, production and staff specialists give the Division the full range of capabilities required in all phases of the management of its complex weapon and space system programs.

The Division has experience in depth in such areas as supersonic aerodynamics, systems engineering, electronics engineering and manufacturing. Emphasis on quality control and reliability engineering has contributed toward the Division's outstanding record of performance in systems management. It has also assured the design and development of superior products, manufactured and delivered on schedule, at lowest cost.

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power. The cyclotron radiation is about equal to the fusion power, which is advantageous in our case.

We can now calculate the specific impulse; this is shown in Table 3. We note that the mass flow rate of the lithium must be such that the total neutron and bremsstrahlung power is absorbed by heating the lithium to vapor. The values given are all in terms of unit volume of fusion plasma. Thus, equating the kinetic energy in the lithium when thrust from the vehicle to 85% of fusion power, we obtain the specific impulse shown of 2200 seconds, which is interesting for many space missions. The factor of 85% arises from assumed nozzle efficiency.

We are now ready to calculate the reactor size. We arbitrarily select the total initial mass of the system to be 100 tons, and require the acceleration to be equal to 1 g. With these specifications, and the specific impulse just calculated, immediately we can obtain the total propellant flow rate, and thus the reactor power and volume.

If the reactor is a torus having a major diameter five times the tube diameter, and space is allowed for lithium flow and heat insulation, etc., the values are those given in Table 3. This is a summary of the items described.

Next to be considered is weight. Weight of the superconducting wire is multiplied by a factor of three to take into account insulation, structural materials to help contain the magnetic pressure of 100,000 pounds per sq. inch, etc. This gives a reactor weight of 12,000 kilograms. Other component weights of the space vehicle are given in Table 3. It will be noted that the propellant is half of the total weight.

We thus come to the mission potential of the system, also shown in Table 3. This yields a total velocity increment of 50,000 feet per second—adequate for many interesting space missions.

**TABLE 1—PHOTOELECTRIC DISSOCIATION OF $H_2^+$ IONS USING VISIBLE LIGHT**

(AH-6 Mercury Vapor Lamp—Average Cross Section = $10^{-17}$ $CM^2$)

| PHOTON INTENSITY (WATTS PER $CM^2$) | MEAN LIFE (SECONDS) |
|---|---|
| 1 | 0.1 |
| 10 | $10^{-2}$ |
| $10^2$ | $10^{-3}$ |
| $10^3$ | $10^{-4}$ |

**TABLE 2—SYSTEM DESIGN**

CHOICE OF FUEL

Eq. 1. $D + He^3 \rightarrow He^4$ (3.6 Mev) + $H$ (14.7 Mev)

Eq. 2. $D + D \rightarrow He^3$ (0.8 Mev) + $n$ (2.4 Mev)

Eq. 3. $D + D \rightarrow T$ (1.0 Mev) + $H$ (3.0 Mev)

ILLUSTRATIVE REACTOR CONDITIONS

Magnetic Field, $B$: 400,000 Gauss

$kT_i$: 100,000 e. v.

$kT_e$: 20,000 e. v.

$nkT/(B^2/8)$: 0.5

$n_D = n_{He^3}$: $7 \times 10^{15}/CM^3$

$n_e$: $2 \times 10^{16}/CM^3$

POWER DENSITY (Watts Per $CM^3$)

$P_{D\text{-}He^3} = 3 \times 10^4$

$P_{neutron} = 7 \times 10^2$

$P_{bremms.} = 2 \times 10^3$

$P_{cycl.} = 3 \times 10^4$

**TABLE 3—PERFORMANCE AND SPECIFICATIONS**

SPECIFIC IMPULSE

$\triangle H$ (Lithium) = $2.8 \times 10^7$ Joules/KG

$(dm/dt) = (P_{brem} + P_n)/\triangle H$

$\frac{1}{2}(dm/dt)U^2 = 0.85 P_{D\text{-}He^3}$

$U$ = 22,000 meters/sec

PERFORMANCE SUMMARY

| | |
|---|---|
| Total Initial Mass: | 100 tons |
| Acceleration (Thrust/Mass): | 1 g |
| Specific Impulse: | 2200 sec. |
| Total Power: | $1.3 \times 10^{10}$ watts |
| Plasma Volume: | $7 \times 10^5$ $cm^3$ |
| Reactor Torus Dimensions: | |
| Minor Diameter = 2 ft. | |
| Major Diameter = 6 ft. | |

WEIGHT ALLOCATION

| | Kilograms |
|---|---|
| Payload (Crew, Etc.) | 25,000 |
| Reactor | 12,000 |
| Helium Refrigerator, Etc. | 3,000 |
| Tankage Plumbing, Etc. | 5,000 |
| Miscellaneous | 5,000 |
| Propellant | 50,000 |
| TOTAL: | 100,000 |

MISSION POTENTIAL

$\frac{\text{FINAL MASS}}{\text{INITIAL MASS}} = 0.5 = \exp(-\triangle U/U)$

U = 22,000 meters/sec

U = 15,300 meters/sec

U = 50,000 ft./sec

## SUMMARY

The opening portion of this paper dealt with performance requirements necessary to justify a costly development: the minimum objective is a high-acceleration, high-specific-impulse system. Next we discussed prospects for fusion power, and the role of such units in space propulsion systems.

Following this was a discussion of a method of fusion plasma production employing photoelectric dissociation. For this, photon intensity of the order of 1 kilowatt per $cm^2$ is necessary; this should soon be available because of research and development associated with laser technology. With this method of plasma production, we expect to obtain useful information about the details of plasma instabilities; when the causes are clearly understood, one may determine the appropriate remedies.

In the second half of the paper we sketched our conceptual design of a space propulsion system employing fusion power. Plasma stability was assumed, also availability of magnetic fields of 400,000 gauss. By appropriate injection of material, two zones of plasma are formed. The inner region represents the fusion zone, which operates on the basis of the D-$He^3$ reaction.

The fusion power density is about $3 \times 10^4$ watts per $cm^3$. This power is transferred from the ions to the electrons, and the electrons in turn radiate nearly all of it in the form of cyclotron power.

The outer region of the magnetic field contains the second zone, which is the propellant plasma. This has a much lower temperature than the fusion region, and a correspondingly higher density. It intercepts essentially all of the cyclotron radiation. The bremsstrahlung power and the neutron flux which penetrate through the propellant plasma produce heating of the vehicle and this is removed by the enthalpy change of the lithium acting as a coolant.

The torus that contains the two plasma zones has a minor diameter of about two feet, and a major diameter of about six feet. The mass of the superconducting coils is four tons, which we multiply by an arbitrary factor of three for structural material, to give a total mass of the reactor and thrust augmenting unit of about 12 tons.

The capability of this system, assuming that everything works, is described by the illustrative example: payload of 25 tons, propellant of 50 tons, auxiliary equipment of 25 tons, gives an initial total mass of 100 tons. The specific impulse of the system is a little over 2,000 seconds. The total increment in velocity is 50,000 feet per second. The acceleration of the system is about 1 G.

One may conclude that such performance is worth a considerable effort. It would indeed take a considerable effort, even if a stable fusion plasma were at hand, and even if superconductors of desired characteristics were available, because many important problems remain to be solved. Consideration of a conceptual propulsion system gives an appreciation of the need for information regarding plasma thrust augmenters, plasma zones that are adjacent but not intermingled, absorption of bremsstrahlung and cyclotron radiation in dense plasmas, and a host of practical engineering problems. ⌗

# Photon Rocket Proposed for Deep Space

MIAMI, FLA.—The real problem in space propulsion is not that of reaching the planets from Earth but of reaching out beyond this solar system.

Even the fusion rocket, according to NASA's Dr. Ernst Stulinger, is not the ultimate. To get to the stars will require a photon rocket capable of achieving a speed approaching that of light.

Stuhlinger, Director of Research Projects Division at the Marshall Space Flight Center, told the 1962 National Symposium on Space Electronics and Telemetry here that several "insurmountable" problems still face photon-rocket developers. However, he declared, a functional model already exists—a common flashlight if placed in outer space would attain a velocity of about 1 ft./hr. before its battery ran dead.

A practical space rocket, he continued, would run into such problems as absorbing 3 megamegawatts of power, an order of magnitude which no structure that we now know could withstand.

As for a fusion rocket, Stuhlinger said that it is not certain whether an ideal model will ever be invented. Even if the problem of a controlled fusion reaction is solved, attendant engineering problems are so great that they too may be insurmountable. As an example, Stuhlinger cited the stagnation temperature in the exhaust of a fusion rocket which may reach up to 10 billion degrees K.

• **Electronics' role in space**—Theme of this year's Symposium was "Unlocking the Universe"—a tribute to the important role of electronics in space exploration. Sponsored by the Institute of Radio Engineers Professional Group on Space Electronics and Telemetry, the meeting was attended by more than 1000 and featured technical sessions with more than 40 papers on new developments and techniques in space electronics, as well as hardware exhibits from industry, NASA, and the military.

Fittingly, NASA was especially prominent in the meeting. Many space agency personnel were involved, together with extensive displays featuring an elaborate large-scale model of the *Saturn* and a full-size *Mercury* capsule complete with escape tower.

A classified session devoted to the nation's space program included as speakers Col. R. M. Wray, Asst. Vice Commander, Air Force Electronic Systems Division; Brig. Gen. J. W. Johnston, commanding general, Army Satellite Communications Agency; Capt. W. E. Berg, chief of Naval Astronautics Development; and Kurt Stehling, scientist, NASA Office of Plans and Program Evaluation.

A unique feature of the Symposium, scheduled for Thursday, was a trans-atlantic telephone call relayed via *Telstar* between Miami and Geneva, Switzerland. Primary purpose of the call was to interchange greetings between officials here and those in the International Telecommunications Union meeting in Geneva.

• **Exhibit highlights**—Some 75 companies exhibited developments in missile/space electronics. This was the largest number yet to participate in this symposium.

Among new products introduced was a solid-state vhf fm transmitter reported to be the first built to meet aerospace operational specifications. Developed by Electronic Communications, Inc., it weighs only 36 oz. and is designed to operate in a vacuum and withstand impact and acceleration forces of up to 100 g.

Dynatronics, Inc. unveiled two new developments: a solid-state analog-to-digital converter, which will fly for the first time in the *Saturn S-3*, and a PCM signal conditioner developed for NASA.

Ampex Corporation introduced its new 14-track, 1.5-mc instrumentation recorder, a solid-state unit also billed as a first. The unit was developed to meet the requirements of predetection recording, a rapidly growing application that has posed special problems for recorders. Ampex also showed a new magnetic instrumentation tape especially built for this recorder.

A versatile new PCM data processor, reportedly capable of handling all present and future mission requirements, was shown by Electro-Mechanical Research. This unit will accept variable word-length data within a frame in any word pattern. It also features an extremely wide bit-rate range—from one to one million bits per second.

Radiation, Inc. exhibited its PCM telemetry system now flying in *Telstar*. Its exhibit also included a PCM package for the *Orbiting Astronomical Observatory* and one for *Nimbus*, the advanced weather satellite scheduled for launch next year.

A new solid-state telemetry data reduction system was introduced by Vector Manufacturing Co., which also showed a new 3-watt "true FM" transmitter and a new portable frequency counter with a built-in digital voltmeter. The frequency counter—with a capability of up to one megacycle—is powered by a rechargeable battery.

Motorola's Military Electronics Division, in a hotel suite display, showed its digital command subsystem which controlled the significant mid-course trajectory correction to maneuver *Mariner II* to pass within a few thousand miles of Venus.

Motorola also showed a complete radio transmitter/receiver built with integrated circuits. This interim model was developed for the Air Force to demonstrate compatibility of thin-film and semiconductor integrated circuit techniques. ⌗

## Electronics Industry Blasted

AS MUCH as 60% of the annual $7 billion spent on defense electronic R&D goes for overruns on cost-plus-fixed-fee contracts, says Dr. Eugene Fubini, Deputy Director, Defense Research and Information Systems, DOD.

Several instances of such overruns were cited by Fubini at the Space Electronics and Telemetry Symposium, including the Sugar Grove antenna fiasco, and an unspecified multimillion-dollar contract with excesses of 24% in four months and another 29% in the next four.

Fubini cited as contributing factors, too little consideration to performance and too much emphasis in sales and personnel recruiting competitions. The DOD expert laid some blame on the "American Syndrome"—if it can be done, do it and ignore its necessity or cost—and also attacked what he called the "Crust Theory."

The latter involves groups splitting off, forming new companies which in turn father newer firms composed of "crusts with nothing underneath."

## Emerson Electric Gears for Space Jobs

Shift in name of Emerson Electric's former Electronics & Avionics Div. to Electronics and Space Products Div. is the most recent step in a program to gear the firm for more missile/space projects. Earlier steps included appointment of Dr. Robert L. San Soucie as vice president and technical director, and Richard B. Loynd as vice president for programs of the division.

Establishment of a new Thermodynamics and Chemistry Dept. within the division and spending of $500,000 on expansion of thermochemistry facilities indicate that Emerson considers prospects good for its Thermo-Lag compounds, which are designed to give spacecraft and missiles thermostatic temperature control by sublimation rather than ablation (M/R, Aug. 31, 1959, p. 28). Managing the new department is Ruben K. Feldman, who developed the compounds.

Thermo-Lag is being used as part of the protection system on *Polaris A2, Saturn, Thor-Delta* and other missile/space systems. Walter Schirra's space capsule bore a test patch of the material in the first evaluation of the material for manned space flight.

## Lockheed Acts, Speaks on RIFT

A Lockheed Missiles & Space Co. test run has confirmed feasibility of moving *RIFT* nuclear rocket stages from Port Hueneme, Calif., to Jackass Flats, Nev., though in some places clearance may be as little as six inches. The company moved a road gage trailer over the 435-mile route planned for five *RIFT* stages to travel to AEC's proving ground for static tests. . . . *Lockheed is presently arguing that as much as $20 million can be saved on RIFT production by use of existing facilities at Moffett Naval Air Station, Calif. As NASA choice of a site nears, Congressmen from the South and Midwest reportedly are applying pressure to have their districts picked for the facility. Decision may be delayed until after Nov. 6 elections to reduce criticism of putting another missile/space facility in California.*

## Industry Facilities

Westinghouse Electric Corp. will consolidate its molecular electronics division at a new 90,000-sq.-ft. facility to be built on 70 acres near Baltimore. Present ME activities at Pittsburgh and Youngwood, Pa., and Baltimore will be concentrated at the site, but the astroelectronics department of the division will remain at Newbury Park, Calif. Construction will begin shortly, and the facility is expected to be operational by next spring. . . . *North American Aviation, Inc., has placed scientists, technicians and support personnel of its Science Center in leased quarters at Canoga Park, Calif. Construction of full-scale facilities in nearby Conejo Valley is under way.* . . . General Precision, Inc., is building two new buildings for the San Marcos, Calif., branch of its Librascope Div. The branch produces guidance computer equipment for *Centaur.* . . . *Geophysics Corp. of America has opened a new branch office at Salt Lake City, Utah, in support of a meteorological research program for the Army Chemical Corps at nearby Dugway Proving Ground. Dr. Harrison E. Cramer will head the office.* . . . Thiokol Chemical Corp. will build and install a new instant steam generation system for the Edwards AFB facility of California Institute of Technology's Jet Propulsion Laboratory. Heart of the system is a combustor generating about 300,000 lbs. of steam per hour at 300 psig.

## Industry Firsts Claimed

Boeing Co.'s first manufacturing-type operations for the *Advanced Saturn* booster were completed with successful test-rolling of a 37-ft.-by-5-in., 5400-lb. aluminum billet at Ingalls Shipbuilding Corp. The billet will be used in forming the *Saturn* "Y" ring, integral part of the fuel tank and outer structure. . . . *The first decade of operation by Thiokol Chemical Corp. of its Longhorn Div. for the Army was marked by ceremonies at Marshall, Tex., recently. Since 1952 more than 126,000 motors requiring over 20 million pounds of solid propellant have been produced and shipped; more than $88 million has been spent on rocket projects; and total contract value has topped the $103-million mark.* . . . The Naval Research Laboratory has given the Smithsonian Institution a photo mural made from 181 separate exposures taken by an *Aerobee*-mounted camera. The mural shows a composite view of a large segment of the Earth. The Navy *Aerobee*, made by Aerojet-General, carried the camera 100 miles up, and pictures were taken before parachute descent.

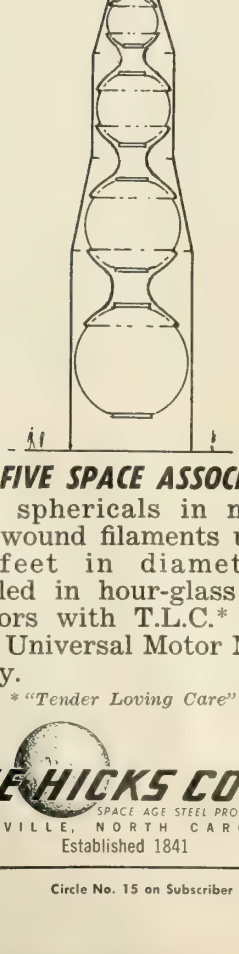
## Other News Notes

The National Science Foundation's U. S. Antarctic Research Program will continue *Argus* rocket firings over the South Pole this season. The shots, made from McMurdo Station, will cull data on winds and temperatures 150,000 ft. up. Extreme weather conditions and technical problems hindered past efforts. The rockets are provided by Atlantic Research Corp. and fired by Texas Western University personnel. Other hardware is donated by the military. . . . *Effective next July 1, Air Force Communications Service will reduce the number of its subordinate echelons in the U. S. from six to three geographical regions—Eastern, Central and Western.*

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## New Product of the Week:

## Pyrometric Molarc Lamp

A radiation standard that may be used for accurate calibration of pyrometers at high temperature, or as a comparison source in spectroscopy is available from Mole-Richardson Co. Its absolute brightness temperature is 3803° K with an uncertainty of −20°. The spectral radiance of the source is close to 3800° K temperature throughout the spectral range of 3000 to 42,000 Angstroms, except for a few isolated wavelengths. The pyrometric molarc lamp requires a direct-current power source with negligible voltage ripple component, together with an arc-stabilizing vernier-adjustable series ballast resistance as furnished by its associated pyrometric molarc power supply Type 2381, which operates from a 120-volt, single-phase, 60-cycle 20-amp ac circuit.

Circle No. 225 on Subscriber Service Card

### Waveguide Shorting Switch

A waveguide shorting switch with 60-db isolation has been developed by Microwave Development Laboratories, Inc. This unit, Model 90SW106# is available in EIA waveguide size WR90, operates over the frequency range 8.5 to 9.6 GC/sec. and has 60-db minimum protection.

Circle No. 226 on Subscriber Service Card

### Rapid Photoprocessor

The Rapidata (R) 904 Photoprocessor, to handle a variety of 16, 35 or 70-mm films for rapid processing, has been developed by Photomechanisms, Inc. Various chemical kits provide for processing a number of photosensitive materials including negative, reversal and two-color data-recording films and photographic papers.

Typical uses are: processing telemetered information, recorded engineer data, computer outputs, medical films, microfilms. The unit is fully automatic. Strict control over agitation, time, temperature, and solution freshness assures uniform results.

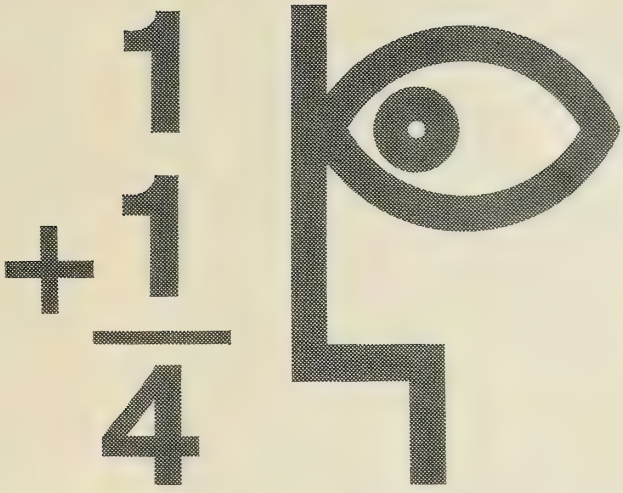
Circle No. 227 on Subscriber Service Card

### Video Flim Recorder

A video film recorder that provides professional broadcast recording quality has been developed by Vue-Tronics, Inc. Designed for broadcast and industrial applications, Model RK-120 is also being used by the aerospace industry for numerous applications, including training and failure analysis.

Included in the new features are horizontal synchronization, either automatically controlled, or line by line control for video tap transfers, a selector switch to reverse picture polarity for direct positive films, and a retrace blanking generator that provides independently adjustable horizontal and vertical blanking pulses. Dubbing can be accomplished through microphone inputs capable of mixing. Constant signal levels are provided over a wide range of input levels with an adjustable AGC amplifier.

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# How to verify this Equality:

When a major electronic system is designed, the overall configuration should be so structured that it provides a far greater capability than the simple sum of the capabilities of all its subsystems.

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## AN IMPORTANT PROGRAM IN THE SYSTEMS DIVISION— MMRBM

The Systems Division is engaged in a major new program to provide stellar inertial guidance for MMRBM, the Mobile Mid Range Ballistic Missile. Other efforts are currently concentrated in the following areas: Guidance and Control Systems for Missiles and Space Vehicles; Aerospace Ground Support Equipment Systems; Aerospace Tracking and Detection Systems; Airborne Command and Control Systems. These activities will entail substantial staff increases *—within the next three months.*

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**SYSTEM ENGINEERS...GUIDANCE & CONTROL.** Positions at senior and intermediate levels for synthesis, anlaysis and design of sophisticated and advanced digital, stellar inertial guidance and control systems. Requires BSEE, 3-8 years experience.

**MISSILE OPERATIONS ENGINEER... LAND & MARINE INERTIAL SYSTEMS.** Define guidance and control, as well as overall operational requirements of advanced missile weapons system. Will evaluate established land and sea navigation systems, performance data and create interface specifications for missile-borne stellar inertial systems. Most desired experience would combine detailed knowledge of inertial systems theory and field operational experience with such weapons systems as ATLAS, MINUTEMAN, POLARIS, etc. Additional military experience helpful.

**PROJECT MANAGER...ANALOG CIRCUITS.** Organize and direct engineering staff involved in R&D of servo amplifiers, resolver buffer amplifiers, operational amplifiers, electronic integrators, regulated power supplies and oscillators.

**SENIOR PROJECT ENGINEER... ANALOG COMPUTERS.** Assume project responsibility for D&D of advanced airborne navigational computers, including inertial doppler and air data types. Requires BSEE or ME with experience in servomechanisms, error analysis and stability criteria.

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**OUCH.**

Vibrations in the "high-Q" region have caused this astronaut to lose control of his space craft — an abort is certain. He will have a cup of coffee before his next flight. ■ Hazards of space flight are regularly duplicated in the moving-base manned aerospace-flight simulator at the Vought Astronautics SPACE ON EARTH Center . . . with realism right down to the bone-shaking vibrations which wring an involuntary "Ouch" from test pilots. ■ The flexibility of the Vought simulator equipment permits it to mimic a wide variety of air and space craft with minimum modification, so that valuable information for America's space program is gathered without risk to human life or expensive equipment. ■ Beyond simulation, Vought Astronautics is at work on many space projects from orbital rendezvous to fuel tanks for Saturn and NASA's Scout rocket system. Write today for the complete story of the concept-to-countdown capabilities of the Vought Astronautics Division.

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## Crystal Filter

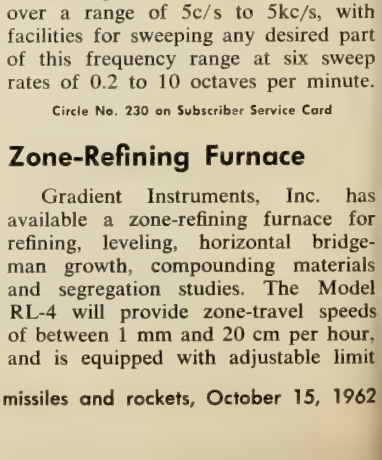
A symmetrical bandpass crystal filter operating at 100 kc, with a 3-db bandwidth of 30 cps minimum and a 60-db bandwidth of 180 cps maximum, has been developed by Systems Inc. Designed for use as a pilot filter in single sideband communications receivers, Model BP-100-030A, provides two outputs whose relative phase varies by 90 degrees over the passband. When used with a suitable phase detector, the unit can be employed as a narrow-band frequency discriminator for automatic frequency control applications. Insertion loss is 5 db maximum with input and output impedance of 50 k ohms.

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## Vibration Testing

A series of instruments for vibration excitation, inspection and control has been developed by Dawe Instrument Co.

Vibration testing has two main objectives—to locate and investigate the source of vibration and to aid the design of components, assemblies, and instruments to withstand the higher vibration levels. The Dawe Instrument Co. setup comprises three main instruments—the Type 444 automatic sweep oscillator, Type 1208 varyphase strobe unit and the Type 1437 vibration control amplifier. The automatic sweep



oscillator provides vibration excitation over a range of 5c/s to 5kc/s, with facilities for sweeping any desired part of this frequency range at six sweep rates of 0.2 to 10 octaves per minute.

Circle No. 230 on Subscriber Service Card

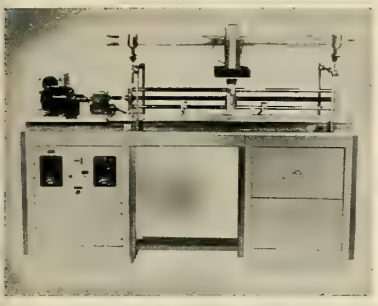
## Zone-Refining Furnace

Gradient Instruments, Inc. has available a zone-refining furnace for refining, leveling, horizontal bridgeman growth, compounding materials and segregation studies. The Model RL-4 will provide zone-travel speeds of between 1 mm and 20 cm per hour, and is equipped with adjustable limit



Circle No. 16 on Subscriber Service Card

switches to control rapid return and automatic cycling. The unit is normally used with 2-in.-diameter quartz or Vycor tube and will handle boats up to 30-in. long. Provision is made for RF heating and an RF coil and air cooling are available.



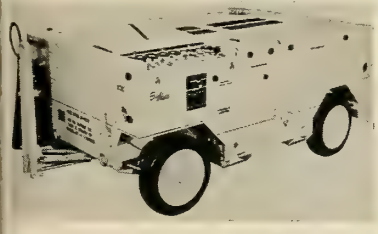
The heater supplied is resistance type usuable to 1200° C and is wound for 220 vac. Two adjustable limit switches are provided to allow the zone to cycle between preset limits. An automatic counter records the number of complete passes.

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## Electric Power Plant

A diesel-driven mobile electric power plant has been developed by Sun Electric Corp. The Model MGS-6 contains a 400-cycle ac generator capable of producing 90 KVA at 115/200 v, 3 phase, and a rectified 28 volts dc at 750 amps (1000 amps intermittent).

The unit's specifications are: voltage regulation ±1 c, transient voltage 25% (dip or rise); transient recovery 0.25 seconds; harmonic content 2%, voltage modulation 0.25%; frequency regulation ±1%, voltage regulation +0.5



volts; ripple voltage 2%, current limiting 950 to 1100 amps or 650 to 750 amps; frequency transient recovery 0.4 seconds (to within ±2% of steady state) or 1.0 second (to within ±1% of steady state).

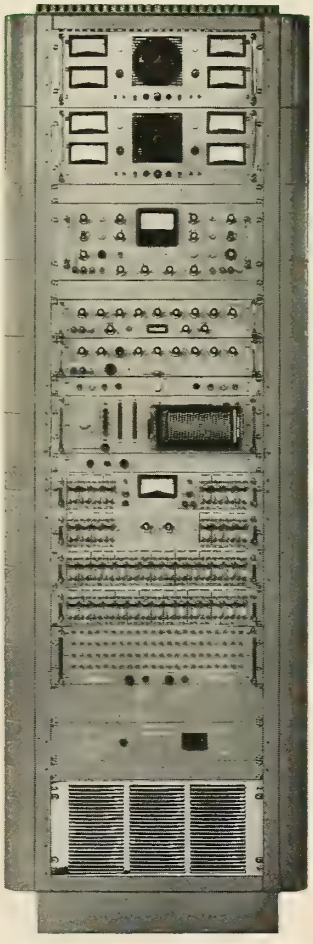
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## Laboratory Dialysis Device

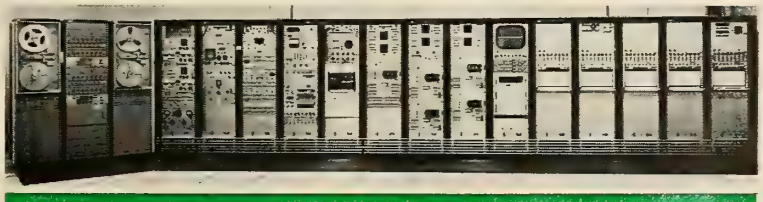
The stackpack, a bench-style, turn-key plant for laboratory evaluations of electrodialysis applications in space


ARNOUX'S SERIES TDS 300 —

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■ Arnoux's PAM, PDM, PAM/NRZ Series TDS 300 decommutator offers improved reliability, improved packaging design, and greater operating ease through less-critical adjustments. Arnoux decoms are widely used and known around the world. Arnoux's telemetry instrumentation and components are backed by an established, solid reputation of leadership in decommutation-equipment design and manufacture. ■ The TDS 300 features an input of from 0.5 to 60 v peak-to-peak . . . switch-selected, standard IRIG pulse rates; optional nonstandard PAM, PDM, PAM/NRZ pulse rates from 5 to 3600 pps . . . automatic compensation for commutation-rate change of up to 40 percent; manual compensation up to 80 percent . . . **unaffected** by SCO dc-level shift and discriminator-frequency zero shift without use of servo (within limits of discriminator pass band) . . . output-signal slope-off of 0.00005 percent/msec of frame (for 5 to 3600 pps) . . . accessory electronic gain and zero servo provides essentially drift-free operation. ■ Shown below: an Arnoux, completely-assembled, 17-rack, telemetry data-acquisition station at a major installation. Five TDS 300's are included, as well as receivers, discriminators, tape recorders, pen recorders, galvanometers, and test equipment.



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technology, is now available from Ionics, Inc.

The stackpack is comprised of a "stack" with 9-in. x 10-in. ion-exchange membranes and electrodes as well as a rectified power supply, tanks, instruments, pumps and plumbing—all premounted to permit "plug-in" startup.

It may be used to obtain all necessary data for process design and cost projections; e.g., electrical and membrane-area requirements may be computed by analyzing the interrelated effects of change in feed composition, flow rates, current density, etc.

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## Refractory Metal Tubing

The complete line of high-purity high-density molecular-formed tungsten and rhenium seamless tubing is available from San Fernando Labs. This tubing has a chemical purity in excess of 99.9% and density in excess of 99.5% of theoretical maximum. Regular tubing is available in seven standard O.D. sizes from 1/16 in. to 1 in., and wall thickness from 0.010 in. to 0.060 in., with lengths to 12 in. Capillary tubing is available in four standard sizes from 0.05mm bore, and wall thicknesses from 0.10mm to 0.50mm with lengths to 10cm.

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## Ultrasensitive Relay

A microminiature relay with welded header construction is available from Babcock Relays, a division of Babcock Electronics, Corp. The precision BR-13 is sealed by an automatic Heliarc welding process, providing a controlled bead at the header-case junction. Since the customary use of solder is avoided, there is no possibility of introducing flux contaminants in the sealing process.

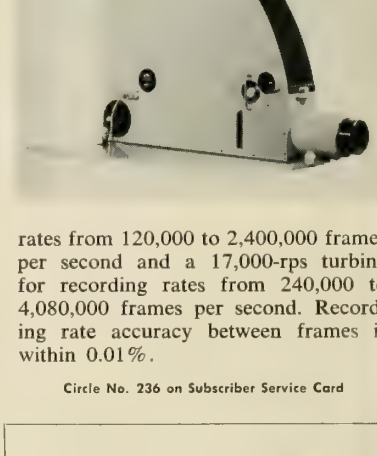
As a further safeguard against contamination, the BR-13 employs a Vycor activated getter. Functioning as an absorptive agent, the getter is capable of eliminating contact fouling by absorbing up to 99% of organic contaminants remaining after production degassing. The unit is designed for dry circuit to 3-amp operation, and meets MIL-R-5757D.

Circle No. 235 on Subscriber Service Card

## Fast Framing Camera

A high-speed synchronized framing camera has been developed by Beckman & Whitley, Inc. Model 189A records 25 high-resolution, 35mm pictures at rates from 48,000 to 4,080,000 frames per second, and is designed for use in the study of such ultra high-speed phenomena as lasers, plasmas, hypervelocity impact, cavitation, nucleation, dynamic stress propagation, detonations, shock and vibrations.

The standard turbine for Model 189A is self-lubricating and operates at speeds from 200 to 5000 rps for recording rates from 48,000 to 1,200,000 frames per second. Two other turbines are also available for this camera: a 10,000-rps turbine for recording



rates from 120,000 to 2,400,000 frames per second and a 17,000-rps turbine for recording rates from 240,000 to 4,080,000 frames per second. Recording rate accuracy between frames is within 0.01%.

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# —names in the news—

**E. J. Flannery:** Appointed chief engineer of the Vap-Air Div. of Vapor Corp., Chicago.

**Louis B. Horowitz:** Named manager of the Systems Div. of Beckman Instruments, Inc., Fullerton, Calif. **Robert J. Baumann** named manager of the Spinco Div., Palo Alto, Calif.

**Edward Moon:** Appointed supervisor, quality control staff for the St. Petersburg, Fla. division of Electronic Communications, Inc.

**Harry W. Scudlo:** Named manager of manufacturing for Standard Products Inc., Wichita, Kans.

**A. L. Bethel:** Appointed manager of the new systems department of the Westinghouse Astronuclear Laboratory, Large, Pa.

**E. R. Perry:** President and director of the National Vulcanized Fibre Co., Wilmington, Del., elected president of the National Electrical Manufacturers Assn.

**Andrew Williams:** Named cost reduction manager for *Apollo* at Lockheed Propulsion Co., Redlands, Calif.

**Robert B. Phinizy:** Promoted to president and manager of the Western Div. of IMC Magnetics Corp., Maywood, Calif.

**Charles H. Carter, Jr.:** Named general manager of Atlas Chemical Industries, Inc.'s Aerospace Components Div., Tamaqua, Pa.

**Alessio Mezzina:** Appointed director of physical and electronic research for Leesona Moos Laboratories division of Leesona Corp., Jamaica, N.Y.

**William I. L. Wu:** Appointed director of research and development at Singer Metrics Div. of the Singer Manufacturing Co., Bridgeport, Conn.

**Lawrence Miller:** Appointed manager of government relations at Philips Laboratories Div. of North American Philips Co., Inc., Irvington-on-Hudson, N.J.

**Harry H. Wetzel:** Appointed executive vice president of the Garrett Corp., Los Angeles.

**Dr. James E. Storer:** Appointed director of the Applied Research Laboratory of Sylvania Electronic Systems Div. of Sylvania Electric Products, Inc., Waltham, Mass.

**Capt. William C. Fortune, USN:** Named project manager of the NASA Marshall Space Flight Center's Mississippi Test Facility.

**Kenneth J. Carlson:** Appointed vice president and general manager of Microlab, Livingston, N.J.

*(Continued on page 46)*




# *Can You Win in Three Moves?*

Of course you can! The logic processes aren't too complicated. But if you have a really complex instrumentation problem, look at the development of the new 500 Series printed circuit plug-in modules. These solid state building blocks allow Vitro to deliver custom-designed land-based and ship-borne instrumentation on *almost off-the-shelf time scales*. These field-proven circuits insure the highest standards of performance and reliability in timing systems, radar data transmission systems, tape search equipment, camera control equipment, ECM evaluation systems, and a variety of related instrumentation. Let Vitro bid on your data handling systems. For complete information write or call the New Projects Manager, Vitro Laboratories, 200 Pleasant Valley Way, West Orange, New Jersey. (area code 201) REdwood 1-3400.

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LYNX
AURIGA
NASA plans for advanced space programs.
GEMINI
NASA selects Lunar Orbit Rendezvous for first manned lunar landing.
NASA's Mariner Venus probe on course.
CANCER
CANIS MINOR
ORION
MONOCEROS

# NASA

*november 26* **MISSILES & ROCKETS SECOND ANNUAL NASA ISSUE**

*During the months following November, the National Aeronautics and Space Administration will make final procurement and development decisions on many major programs: Aeros/Advanced Relay/Nova Super Booster/Advanced Syncom/Lunar Logistics Supply Vehicle/Lunar Exploration Module for the Apollo Spacecraft. Each program means millions of dollars to be spent in the missile/space industry.*

*M/R's editorial task force will visit NASA headquarters and each field center to gather in-depth information on the space agency's present and future programs/budget breakdowns and projections/future contracting procedures/development and launch schedules/new technical requirements/prime and sub-contracting opportunities.*

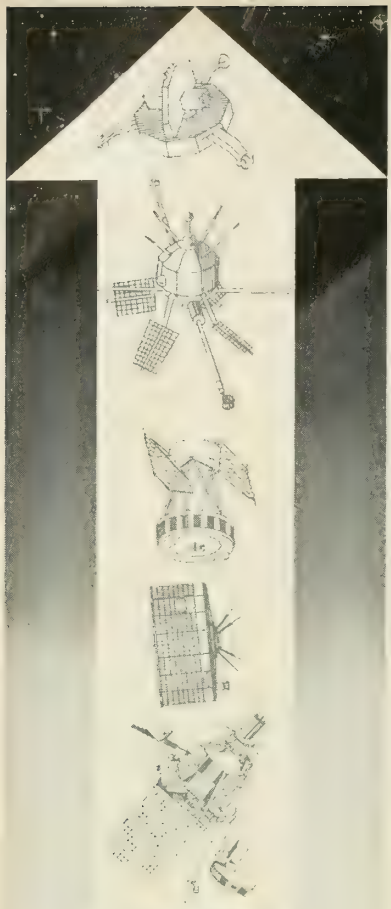
*Advertisers in this issue will benefit from systems-oriented editorial coverage of all NASA's program and project developments . . . 40,106 current paid circulation . . . 1000 bonus circulation to key NASA personnel . . . readership by the NASA executives making the procurement decisions.*

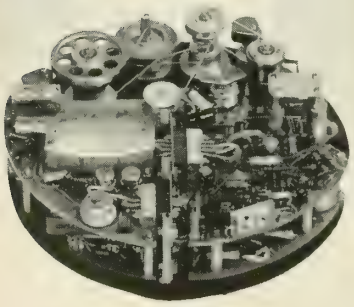
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*Advertising closing date: november 5, 1962*
*issue date: november 26, 1962*







# Tape Recorders

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## *names in the news*

*(Continued from page 43)*

**Stuart E. Arnett:** Appointed director of marketing for ITT Industrial Laboratories Div. of International Telephone and Telegraph Corp., Fort Wayne, Ind.

**Roswell M. Huff:** Appointed western regional sales manager of the Defense and Industrial Div. of Otis Elevator Co., Santa Ana, Calif.

**Frederick W. Hesse, Jr.:** Appointed vice president for corporate operations at Thompson Ramo Wooldridge's Space Technology Laboratories, Redondo Beach, Calif.

**Dr. Hal Ellis:** Appointed manager of Marquardt Corp.'s reliability and product integrity dept., Power Systems Div., Van Nuys, Calif.

**Dr. James Reekie:** Formerly with Plessey Co., joined Bell & Howell research center, Pasadena, Calif., as director of physics research.

**K. E. Neudoerffer:** Appointed manager of Lockheed Aircraft Service Co., Ontario, Calif.

**M. E. Harrison:** Named director of engineering of Bourns, Inc., Trimpot Div., Riverside, Calif.

**Dr. C. H. Sutcliffe:** Appointed director of engineering for Philco Corp.'s Lansdale Div., Lansdale, Calif.

**Jack B. Hippler:** Appointed manager of aerospace development sales of Lockheed-Georgia Co., Marietta, Ga.

**Cornelius P. McNamara:** Appointed vice president of the Emerson Research Laboratories Div. of Emertron, Inc., Silver Spring, Md.

**Dr. Werner R. Kirchner:** *Polaris* missile pioneer appointed a vice president of Aerojet-General, Sacramento, Calif., and assistant manager of the Liquid Rocket Plant.

**Stephen P. Dillon:** Appointed manager of major subcontracts for Douglas Aircraft Co.'s Missile & Space Systems Div., Santa Monica, Calif.

**Ronald S. Gall:** Assistant to the president and corporate director of public relations of Curtiss-Wright Corp., Wood-Ridge, N.J., presented with a citation from Aviation/Space Writers Assn. for his many contributions toward raising the standards of public relations in the aviation/space industry.

**Henry B. Ahlberg:** Named assistant to the president of Commercial Filters Corp., Melrose, Mass.

**Jack Shaver:** Appointed manager of international programs at Douglas Missile & Space Systems Div., Santa Monica, Calif.






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## AWARDS

### AIR FORCE

$122,831,000—**Boeing Co.,** Seattle, for continued work on the *Minuteman* missile program (2 contracts).

$23,655,000—**Martin Marietta Corp.,** New York City, for follow-on work on the *Titan II* missile (supplemental contract). Work to be done at Denver.

$7,860,000—**Martin Marietta Corp.,** New York City, for work on test and activation of a *Titan II* training force at Vandenberg AFB (supplemental contract).

$5,970,000—**Martin Marietta Corp.,** New York City, for research and development for the *Titan II* weapon system. Work to be done at Denver, Baltimore and Cape Canaveral.

$5,750,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for additional work on *Agena* space programs.

$5,191,371—**Boeing Co.,** Seattle, for spare parts for *Minuteman* missile ground equipment.

$5,051,000—**Avco Corp.,** New York City, for work on *Mark II* re-entry vehicle and related equipment. Work to be done at Wilmington, Del.

$5,049,000—**Avco Corp.,** New York City, for work on *Mark V* re-entry vehicle and related equipment. Work to be done at Stratford, Conn.

$2,000,000—**Philco Corp.,** Philadelphia, for work on control subsystems for space programs. Work to be done at Palo Alto, Calif.

$2,000,000—**Radio Corp. of America,** Burlington, Mass., for further work on final-stage vehicles for space programs.

$1,500,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for provision of a fuze capability for an air-to-air rocket (supplemental contract).

$1,000,000—**Avco Corp.,** New York City, for work on *Mark V* re-entry vehicle. Work to be done at Wilmington, Mass.

**Ford Motor Co.'s Aeronutronic Div.,** Newport Beach, Calif., for a study to help bring information display techniques into line with current high-speed communicating computer and electronic technologies (undisclosed amount).

### ARMY

$50,000,000—**Douglas Aircraft Co.'s Missile & Space Systems Div.,** Santa Monica, Calif., for continued research and development of the *Nike-Zeus* missile.

$18,662,500—**Bendix Corp.'s Eclipse Pioneer Div.,** Teterboro, N. J., for guidance and control systems for the *Pershing* missile.

$12,107,326—**Western Electric Co.,** New York City, for engineering services for the *Nike-Hercules* missile system.

$9,001,357—**Sperry Rand Corp.'s Sperry Utah Div.,** Salt Lake City, Utah, for engineering services on the *Sergeant* missile system.

$6,117,887—**Bendix Corp.'s Eclipse Pioneer Div.,** Teterboro, N. J., for engineering services for *Pershing* missile guidance and control components.

$1,900,000—**Melpar, Inc.,** Falls Church, Va., for a feasibility study for a forward area intelligence substation (ELINT).

### NAVY

$10,800,000—**Vitro Corp. of America's Vitro Lab,** Silver Spring, Md., for continued systems coordination engineering work on *Polaris* fleet ballistic missile system.

$10,560,960—**General Electric Co.,** Schenectady, N. Y., for research and development work on nuclear propulsion plants for Navy ships.

$4,131,000—**General Electric Co.,** Cincinnati, for work on *Polaris* missile fire control systems and guidance equipment.

### NASA

$566,574—**Ross Corp.,** New Orleans, La., for building the foundation of a vertical assembly, hydrostatic test and cleaning facility which will be used in the *Saturn C-5* booster program.

$300,321—**Martin Marietta Corp.,** Denver, for conducting a *Nova* launch facilities study.

$225,000—**Tenney Engineering, Inc.,** Union, N. J., for a space facility for simulating a trip to Mars, Venus and back to Earth for the *Saturn* program. Facility will be installed at the George C. Marshall Space Flight Center.

$148,750—**Microdot, Inc.,** South Pasadena, Calif., for 90 channel temperature systems for use in research and development of the *Apollo* spacecraft.

### INDUSTRY

$1,750,000—**Albert C. Martin & Associates,** Los Angeles, from **Lockheed-California Co.,** to plan, design and engineer a new laboratory to house vehicle systems and structures development activities.


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$1,700,000—**Jordan Electronics Div. of Victoreen Instrument Co.**, Alhambra, Calif., from **Sperry Utah Co.**, for continuation of the manufacture of the guidance power supply for the *Sergeant* missile.

$382,000—**Kinetics Corp.**, Solana Beach, Calif. from **Martin Co.'s Space Systems Div.**, for delivery of motor-driven switches to be used on the *Gemini* spacecraft.

$362,000—**Rocket Power, Inc.**, Mesa, Ariz., from **McDonnell Aircraft Corp.**, for work on the *Gemini* rocket catapult escape system.

$254,000—**Rosemount Engineering Co.**, Minneapolis, from **McDonnell Aircraft Corp.**, for temperature sensors to be used in the *Gemini* program.

$67,000—**Engelhard Industries, Inc.**, Newark, N. J., from **Boeing Co.**, for high-temperature thermocouple sensors for the *X-20 Dyna-Soar* program.

**Kelvin Electric Co.**, Van Nuys, Calif., from **International Business Machines Corp.**, for quantities of high-reliability precision wire-wound resistors to be used in *Project Gemini* (undisclosed amount).

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

U. S. Army Engineer District
Corps of Engineers
Federal & Courts Bldg.
650 Capitol Ave.
Sacramento, Calif.

*Nike-Hercules* improvement kit of 87 C, San Francisco Defense Area, (construction of concrete radar-radome foundations, direct burial electrical cable and bituminous paving). Job—IFB ENG-04-167-63-21. Bid opening 10-24-62. $1.00 per set.

---

Corps of Engineers
Ballistic Missile Construction Office
Torrance, Calif.

Construction of strategic missile support base facilities. Proof load test facility, Ellsworth AFB, S. D., consists of a concrete pit with hydraulic cylinders for proof-load testing the transporter-erector, the operational launcher-elevator and work cage, and other maintenance vehicles of the *Minuteman* weapon system. Access roads and utilities required to make this facility usable. Job—IFB ENG-04-548-63-7-B. Tentative bid opening 11-1-62. Plans and specs may be obtained by request to the District Engineer, U. S. Army Engineer District, Los Angeles, P. O. Box 17277, Foy Station, Los Angeles, Calif. Set of plans and specs will be furnished upon receipt of a check or money order in the amount of $2.00 (nonrefundable) made payable to Treasurer of the U. S. All plans and specs must be returned to the Area Engineer, Ellsworth AFB, S. D. Approximate value $75,000.

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Bureau of Naval Weapons
Washington 25, D. C.

For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Associated Testing Laboratories, Inc., Wayne, N. J., for engineering services for testing of *Polaris* fire-control electronic components. Award will be made on the basis of the continuation of a program previously started with the above firm. This notice is made for information purposes only. Other proposals cannot be considered for the above procurement. PR No. SP-1071-63-1. BuWeps Synopsis No. 83-63.

For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Lockheed Aircraft Corp., Sunnyvale, Calif., for MOD VI-A hydraulic packages for *Polaris A3* first-stage motors. This notice is made for information purposes only. Other proposals cannot be considered for the above procurement. PR No. SP-1082-63-4. BuWeps Synopsis No. 87-63.

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Directorate, Procurement and Production
Hq., Middletown Air Material Area
Olmsted AFB, Pa.

Contact technical services for re-entry vehicle (GAM-87), re-entry vehicle MK-6 (SM-68) and re-entry vehicle (SM-65) by 12 technical reps for 73 man-months. Negotiations will be conducted with General Electric Co., Missile and Space Vehicle Dept., Philadelphia. Inquiries must refer to RFP 36-600-63-5419. For information only. No RFP available.

---

Hawk Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

Necessary services to perform final assembly and technical checkout of the *Hawk* missile—1624 each with options for quantities of 202 and 162 each. Work to be performed at Red River Army Depot, Texarkana, Texas. Technical know-how and specialized experience required to assemble and check out the *Hawk* missile precludes award to other than the prime contractor, Raytheon Co., Willow St., Waltham, Mass. All inquiries relative to subcontracting should be referred to Raytheon Co. at the above address.

---

U. S. Army Engineer District
Kansas City Corps of Engineers
1800 Federal Office Bldg.
Kansas City 6, Mo.

Construction of SAC antenna support structures for WS-107A1 operational base missile launch complexes near Forbes AFB, Topeka, Kans. Work to be performed consists of construction of an antenna support structure at each of nine sites, which includes excavation of a shaft approximately 10 ft. wide and 30 ft. deep; installation of steel liner in shaft; installation of government-furnished antenna facilities; modification to existing electrical system to accommodate antenna facilities; construction of access road and seeding. Plans and specs $3.00 per set nonrefundable. Job—IFB 63-19. Bid opening 11-8-62.

---

Procurement and Production
Air Procurement Branch
L. G. Hanscom Field
Bedford, Mass.

Chamber, test, environmental with controlled temperature and pressure to simulate conditions of pressure from 1000 to 0.1 millibars and temperature from 80 degrees to 120 degrees or more —1 each—delivered and installed at Bedford, Mass. IFB 19-628-63-52B. Bid opening 10-26-62. Bidders must not have less than 2 years of satisfactory experience as a supplier of this equipment. Bids submitted must be supported by (A) outline drawings of the chamber, the refrigeration and control systems, (B) data showing system performance, and (C) a mathematical analysis showing how the specifications regarding the temperature of the walls will be met.

---

Directorate, Procurement and Production
Headquarters, Middletown Air Material Area
Olmsted AFB, Pa.

Contract technical services for NT1, test equipment, platform, gyro, accelerometer, age, inertial guidance system, bench maintenance, guidance system, flight control and overall weapon system equipment (GAM-77) by 67 technical reps for 405 man months. Negotiations will be conducted with North American Aviation, Inc., Downey, Calif. Inquiries must refer to RFP 36-600-63-4533. For information only. No RFP available.





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**International Symposium on Space Phenomena and Measurement, sponsored by NASA and AEC,** Statler Hilton Hotel, Detroit, Mich., Oct. 15-18.

**Instrument Society of America's Seventeenth Annual Instrument-Automation Conference and Exhibit,** New York Coliseum and Hotel New Yorker, New York City, Oct. 15-18.

**Symposium on Inertial Guidance Tests,** sponsored by Air Force Missile Development Center, Holloman Air Force Base, N. M., Oct. 16-17.

**Ninth Annual Joint ASLE-ASIE Lubrication Conference,** Hilton Hotel, Pittsburgh, Oct. 16-18.

**Fifteenth Pacific Coast Regional Meeting, American Ceramic Society,** Olympic Hotel, Seattle, Oct. 17-19.

**Electronic Industries Association Meeting,** Seattle, Oct. 17-21.

**Sixth Annual Display, Aerospace Electrical Society,** San Diego, Calif., Oct. 18-19.

**Ninth Annual East Coast Conference on Aerospace and Navigational Electronics,** Emerson Hotel, Baltimore, Oct. 22-24.


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# College Pick: NASA by Five Points

CONGRESS has perhaps inadvertently put the Dept. of Defense in a difficult position regarding research grants. The DOD appropriations act for Fiscal 1963 limits indirect costs of grant research to 20 percent of the direct costs.

The Independent Offices appropriations act, which covers funds for the National Aeronautics and Space Administration, the Space Council and the Office of Science and Technology, among others, provides that such indirect costs may be allowed up to a figure of 25 percent.

This 5 percent discrepancy in the two pieces of legislation already is working to the disadvantage of the Defense agencies. Dr. Knox Millsaps, executive director of the Air Force Office of Scientific Research, is seriously concerned about its effects.

He calls the limitation a "serious setback for the Air Force," and notes that many universities are re-examining their DOD grants and contracts programs in light of the restriction.

According to Dr. Millsaps, Harvard University decided it would for the present accept no new work from AFOSR. The University of Michigan is among others which have been taking a new look at research for the Federal government.

What the discrepancy means is this: NASA and other agencies are in a more favorable position than AFOSR when it comes to vying for the services of top-level university researchers and scientists. A university, naturally, is more inclined to seek grants where the allowance of overhead costs is higher.

DOD does not require an advantage over NASA in this regard. But it does deserve to be on an equal footing.

As a matter of record, it apparently was the initial intent of Congress to put all such agencies on the same basis. The House bill for DOD appropriations at first provided that indirect costs paid on research grants should not exceed 15 percent of the direct costs of the project. The Senate bill contained no such limit.

A compromise figure of 20 percent was reached in conference. It was indicated on the floor of the House that it was the intent of the appropriations committees to establish this as a government-wide limitation on grants.

These plans broke down after the DOD appropriations bill had been passed and signed. The Independent Offices bill was amended to raise the limitation to 25 percent for the agencies covered in that bill.

The discrepancy against DOD thus was created. It does not mean that universities and colleges will cease acceptance of DOD research grants.

"We will have no trouble spending our budget—none at all," says Dr. Millsaps. But he does feel that some basic research areas of high interest to the Air Force may not be covered by the best available scientists—because their universities will prefer to work under NASA grants.

A survey of 1962 grants by AFOSR shows the average overhead rate to be 28.5 percent. Imposition of the limitation is, in effect, asking the universities to subsidize the government for this work. The situation holds true even under a 25 percent limitation, but to a much lesser extent.

Congress should move as soon as possible to eliminate the unfavorable climate it has created for DOD in this regard.

It should, in fact, take a much closer look at the overall picture regarding allowances on research grants. Its attitude toward the problem has seemed somewhat cavalier and haphazard.

No one expects Congress to provide a loophole through which universities can write off large and unwarranted sections of their overhead without Federal control. It should also be noted that grants represent only a minor share of university research and development for the Dept. of Defense. The majority of such work is done under contract.

THAT, HOWEVER, is no excuse for allowing an inequitable position to develop. The universities have contributed to the confusion by the very fact that their overhead charges have varied at times from 10 to 72 percent of direct costs.

The universities should not be asked to subsidize the government; but a limit of some kind clearly is called for to ascertain that the government is not being asked to improperly subsidize the universities. Money for research grants should go, to the greatest extent possible, for research and not for administrative costs.

The 15 percent research limitation written into the Dept. of Health, Education and Welfare bill in 1958 has not unduly discouraged research in that field. It is possible that a 20 percent limitation is entirely just in the areas of interest to DOD and NASA.

It is not necessary for the Federal government to establish a system for control of university accounting systems; it is equally unnecessary to allow free rein to financial opportunists among the colleges. A common-sense compromise must exist, and Congress should find it. But the first order of business in doing so should be abolition of the present discrepancy against DOD research grants.

**William J. Coughlin**

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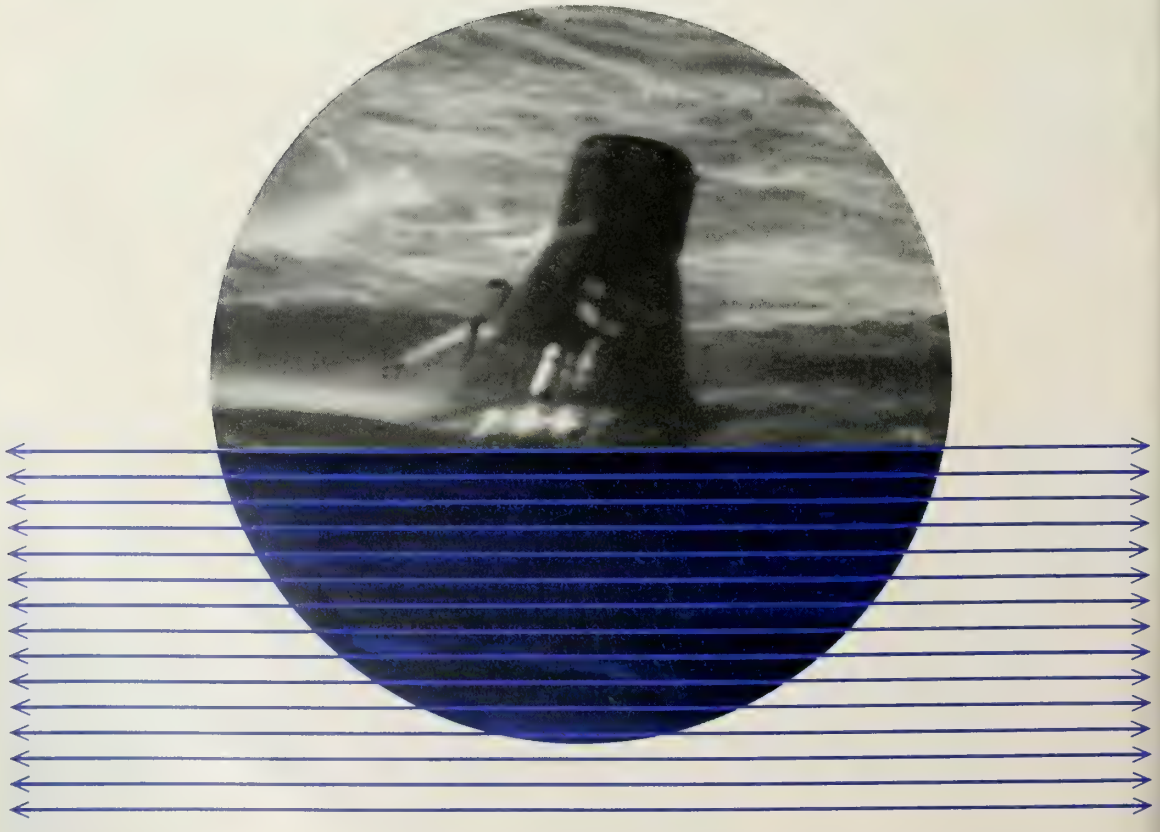
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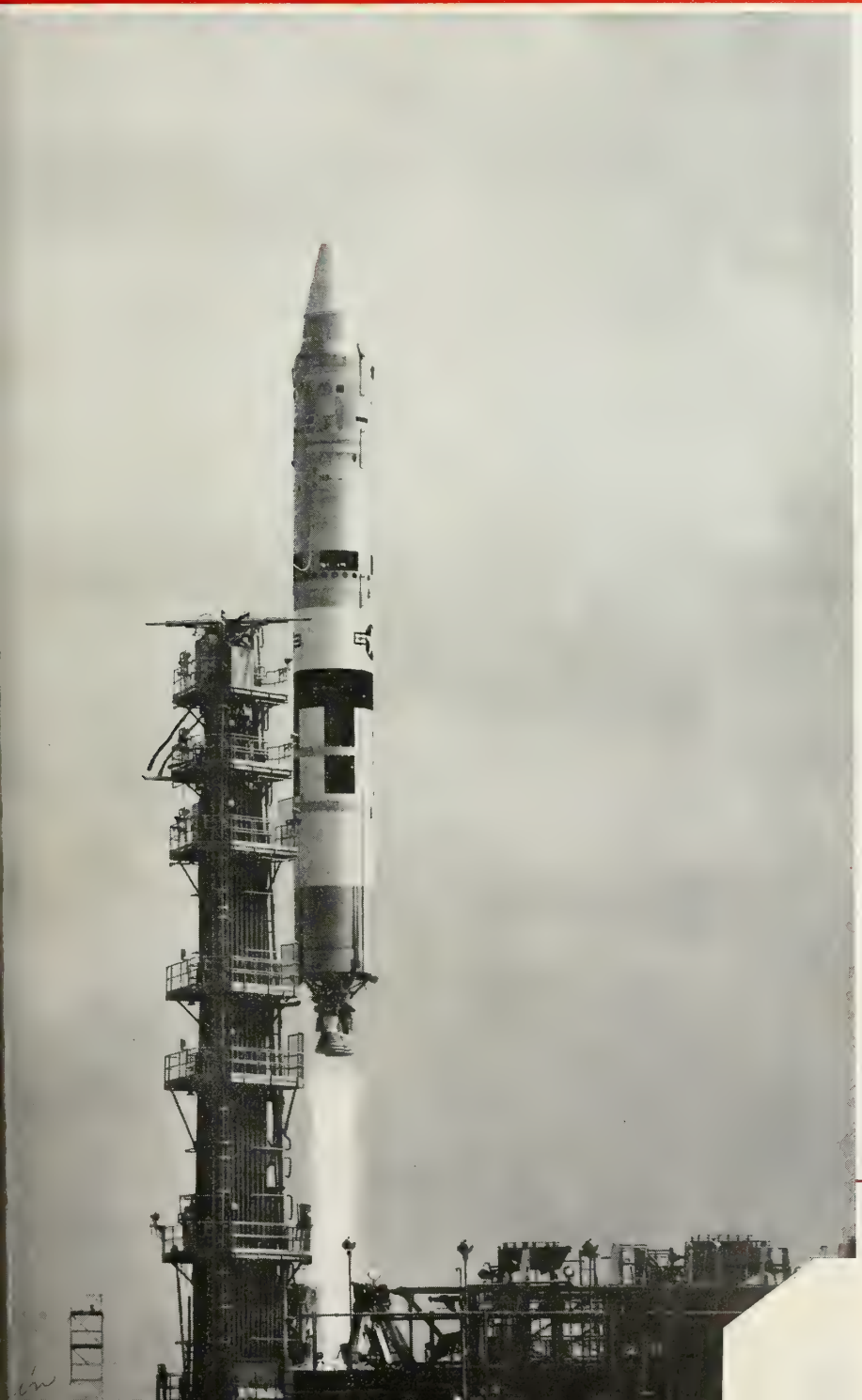
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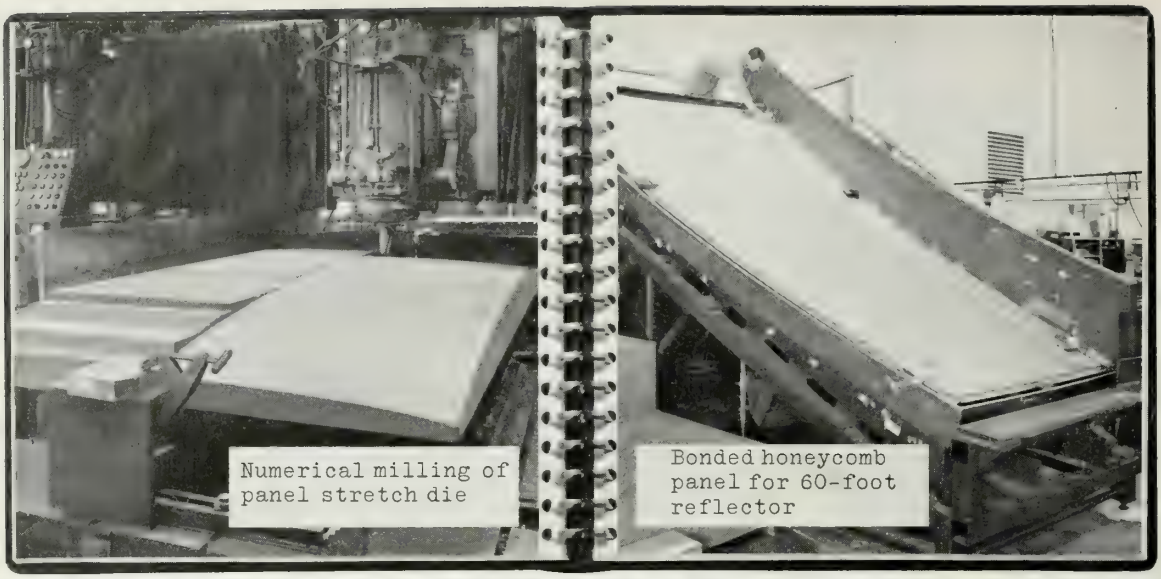
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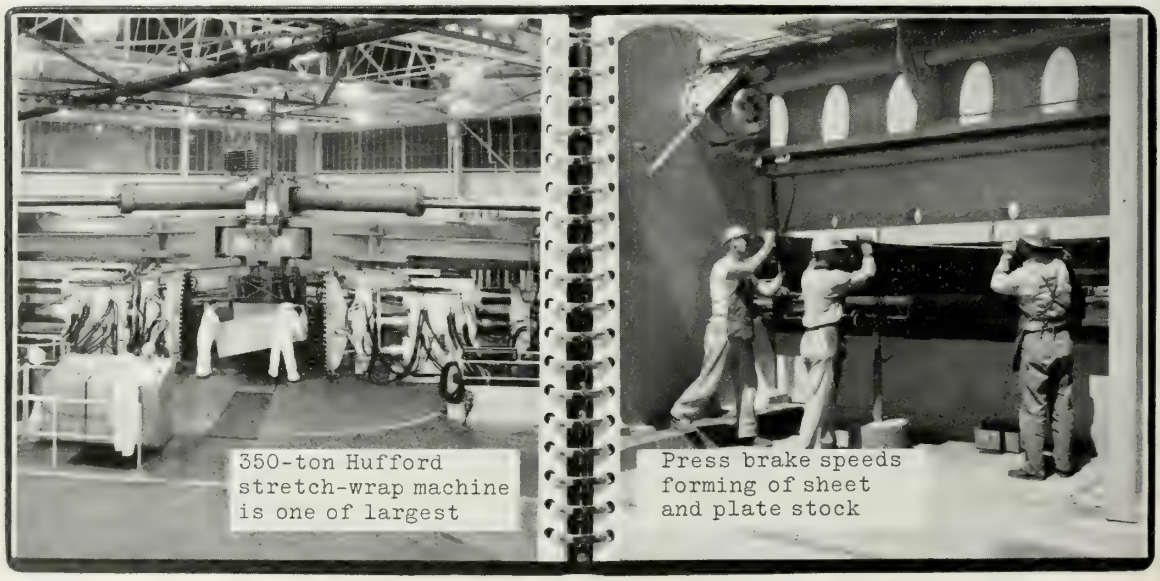


## McNamara Outlines DOD Space Plans

- **NASA Sticks To Lunar Orbit**
- **Paring Apollo Guidance Price**
- **Problems for 'Spy' Satellites**

*Titan II Takes Off On 5000-mile Flight*




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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 17 October 22, 1962

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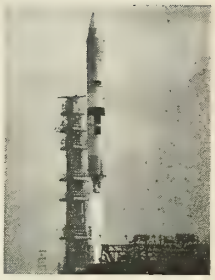
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## THE COVER

*Air Force's Martin Titan II ICBM went 5000 miles across the Atlantic in flight from Cape Canaveral Oct. 12. Fourth success in six test shots, launching checked performance of all subsystems of storable-liquid-fueled missile.*



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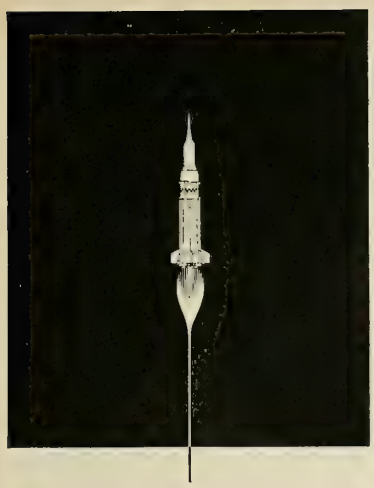
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# letters

## Salary Curb Threat

*To the Editor:*

Hurrah for MISSILES AND ROCKETS' reply to David E. Bell's letter regarding salary ceilings for R&D contractor personnel (M/R, Aug. 20, p. 6).

Thank God for people with sufficient clarity of thinking to see the threat posed to the free enterprise system (and progress) by the degradation of human incentives.

Your forthright and courageous answer to Mr. Bell is very commendable and a great source of encouragement.

James A. Reeves
Executive Vice President
Spacelabs, Inc.
Van Nuys, Calif.

## Employee Rights

*To the Editor:*

Bravo! Bravo! and my thanks for your Sept. 24 editorial ("Move Over, Mr. Blough").

There is much to be said about the company which fights the lonely battle for its employees' rights. As Courtlandt Gross recently told his employees, "We are not anti-union, but we are anti-compulsion."

I commend you, not for your editorial alone, but for the fact that you too have guts enough to stand and call a spade a spade.

Patrick E. Nichols
Lockheed Missiles & Space Co.
Sunnyvale, Calif.

*To the Editor:*

My compliments on the Sept. 24 editorial. I heartily agree with your comments and feel it is one of the best things the magazine has done.

A. V. Cline
Gaynor & Ducas, Inc.
Beverly Hills, Calif.

## Vostok Rebuttal

*To the Editor:*

I have noted with interest the commentary by J. A. Redeker of Rotterdam, Netherlands (M/R, Oct. 1, p. 6) on my letter (M/R, Sept. 3) concerning the relative positions of *Vostoks III* and *IV* during their orbital flights. Mr. Redeker wonders a great deal about my calculations, and he is evidently certain that I am in error. He may be cocksure but alas, he is dead wrong. After all, I do not consider the thrust of my comments anywhere near enough to stop the Earth's spin for 1 second; perish the thought of doing it for 28.8 minutes. A lesson in elementary celestial mechanics seems in order; after 16 orbits by the *Vostok III* spacecraft, the time elapsed was 88.2 min. x 16 orbits = 1411.2 minutes. Since the Earth spins at a rate of (approximately) 15 degrees/60 min., then in 16 orbits the Earth turns

$$\frac{15^\circ}{60 \text{ min.}} \times 88.2 \frac{\text{min.}}{\text{orbit}} \times 16 \text{ orbits} = 352.8^\circ$$

I have chosen 15 minutes as the time from lift-off to orbit injection of the *Volstoks*, hence the Earth has rotated another 3.6° during this interval. Now the nodal regression turns out to be about 3.6 degrees, also, to the west (see Moulton or any other good book on celestial mechanics for this calculation). Hence, the Earth rotates therein a total of some 356.4° and then with the addition of the nodal regression, the launching point is now in the *same* plane—e.g. the apparent total Earth rotation is now 360° (according to theory and the commensurate calculation). The 16 orbits of *Vostok III* took 1411.2 minutes. But we count our day as 24 hours = 1440 minutes. *Vostok III* was launched at 11:30 a.m. Moscow time on Aug. 12; 28.8 minutes earlier, at 11:02 a.m. Aug. 13 Moscow time, *Volstok IV* was launched. The apparent Earth rotation during 16 orbits was 360°; the time, however, was some 28 minutes less than one day, consequently, the need for the earlier launch of *Vostok IV*. You see, we did not stop the Earth at all.

The following items should be noted carefully, and kept in mind. The very best we can do in all these calculations is guided by the insufficiency of our knowledge of orbital parameters, lift-off time, and time to orbital injection from lift-off. There are other items—such as our use herein of 24 hours for the day as opposed to the correct value of a sideral day of 23 hours 56 min. 4.09 sec. In the light of the facts that at low-orbit altitudes the inclination of the orbit plane to the equatorial plane is changing rather noticeably and the orbit period is far from constant, my use of the *Pravda*-given values were probably as good as any available (and useable) in the Western World. In fact, from my experience involving both U.S. and U.S.S.R. calculations of the parameters for Soviet spacecraft and and satellites, I find that the *Pravda*-given values are consistently better, since they do not show the erratic and inconsistent variations made available by U.S. tracking sources. Finally, yes, I assumed the difference in inclination to the equator was also the 2 minutes or arc difference between the orbital planes, this difference being, of course, (presumably) the total error incurred during the Soviet attempts to match the *Vostok III* and *IV* orbits. Since the inclination difference is not necessarily the orbit plane difference —they are not linearly related—the actual variation may have been more or less. Inasmuch as I did not expect to have available all the prior information I desired, I decided to plunge ahead anyhow and sacrifice some accuracy. The results, I believe, are of interest in any case.

Saunders B. Kramer
Senior Member
American Astronautical Society
Fellow
British Interplanetary Society




A new solid state radar system built by STL engineers and scientists can send out and receive signals at X-band frequencies to help man rendezvous and dock vehicles in space. STELATRAC is its name. It is the first solid state system of its kind. The X-band transmitter is shown above. It has successfully passed temperature and vibration tests. STELATRAC can also be used as a command link between vehicles in flight. By altering its module design, the flexible radar system operates as an altimeter and doppler velocity sensor to guide spacecraft safely to the surface of the moon and planets. Today STL is busy on many such projects as STELATRAC. STL is also prime contractor for NASA's OGO and a new series of classified spacecraft for Air Force-ARPA. And STL continues Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in Theoretical Physics • Systems Engineering • Radar Systems • Experimental Physics • Applied Mathematics • Space Communications • Antennas and Microwaves • Inertial Guidance • Analog Computers • Solid State Physics • Computer Design • Telecommunications • Space Physics • Digital Computers • Guidance & Navigation • Electromechanical Devices • Engineering Mechanics • Aerodynamics • Propulsion Systems. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, Department B11, One Space Park, Redondo Beach, California, or Box 4277, Patrick AFB, Florida. Your inquiry will receive a prompt reply. STL is an equal opportunity employer.

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# The Countdown

## WASHINGTON

### Are Midas Troubles Exaggerated?

Dept. of Defense is deliberately over-emphasizing development problems of the *MIDAS* early warning satellite, an AF official charges. He says most of the problems now are solved. Air Force can't defend the program publicly due to security restrictions.

### North American Gets Saturn Contract

NASA contract with North American Aviation for development of the S-II stage of the *Advanced Saturn* totals $319 million. Contract, now signed after months of negotiation, calls for nine flight stages with others for test purposes. It runs through December, 1966.

### NASA Plans Elliptical Tiros Orbit

NASA wants to test one of its *Tiros* weather satellites in a highly elliptical orbit with perhaps a 300-mile perigee and a 3000-mile apogee. This potentially would provide a view of the whole disc of the earth for the first time. If camera coverage were satisfactory, orbits of future weather satellites would be altered.

### Still No Word on the Solid Future

Future of the big solids program still is marking time until NASA Administrator James Webb and Defense Secretary Robert McNamara meet to discuss the program. A remark last week by Air Force Secretary Eugene Zukert that he had not seen the program gave many a misimpression. It has been signed off by Zuckert's office and is at DOD level.

### NASA to Measure Radiation Belt

NASA will attempt this week to measure the size and density of the radiation belt created by the U.S. high-altitude nuclear explosion last July. The space agency's specially designed *S-3B* satellite is scheduled for launch from Cape Canaveral on Oct. 26. All of the spacecraft's experiments are designed to record data on the belt. (M/R, Sept. 17, p. 7.) Meanwhile, JPL scientists report that data from *Ranger III* indicate intensity of radioactive gamma rays in space may be 10 times greater than expected.

### Kennedy Plans Recess ComSat Appointments

President Kennedy will give recess appointments to the 13 board members of the Communications Satellite Corp. The Presidential action is required because the Senate failed to confirm the appointments before its adjournment. The board, meanwhile, already has scheduled its first meetings.

### Edwards Under Study as Recovery Area

Air Force Systems Command headquarters is studying a recommendation that Edwards AFB be the major focal point of the AF Space Recovery Area. An ad hoc committee appointed by Gen. Bernard Schriever recommended a triangular recovery area which would include Wendover AFB, Utah, and the White Sands Missile Range, N.M. No early decision is expected. Both AF and DOD must review the report.

### Watch Out for That Last Third!

Countermeasure operators on AF B-52's say they now can jam a radar-guided surface-to-air missile so effectively in the first third of its flight that no bomber evasive action is required—if the missile is acquired in time. After that, there is a brief period when evasive action would help and then—*adios*.

## INDUSTRY

### Navy Orders Beech Target Missile

A $5-million Navy contract for the *KD2B-1* target missile will enable Beech Aircraft to move into initial production. Follow-on contract for another $10 million is expected before year's end. The Mach 2-plus expendable missile, powered by Rocketdyne's LR-64-NA-4 storable-fueled engine, exceeded design specifications on each of its last seven flights.

### Concern Voiced over Lewis Capabilities

Some NASA officials privately are expressing concern over whether Lewis Research Center can handle the muddled *Centaur* program. They point out that this is the first program of such magnitude for the center. Lewis, meanwhile, is planning to seek help from industry contractors, particularly on guidance and control problems.

## INTERNATIONAL

### RCA Supplies Aberporth Radar

Installation of two powerful high-precision tracking radars has been completed at Britain's missile launching site at Aberporth, Wales. They were supplied by the Missile and Surface Radar Div. of Radio Corp. of America. The radars are of long-range amplitude-comparison type, operable at 1000 kw peak power output, each at 5480 mc/sec. Provision is made for a power increase to 3000 kw.

### Soviets Release New Space Film

"Stellar Brothers," a full-length color film on the training and flight of Soviet astronauts Nikolayev and Popovich in *Vostoks III* and *IV*, is being released in Moscow. As with the Titov film, it probably will be first seen in the West at private showings by Russian embassies.

### New Chairman for France's CNES

President Jean Coulomb of France's National Center for Scientific Research will succeed Pierre Auger as chairman of the French National Space Center (CNES). This follows nomination of Prof. Auger as president of the European Space Research Organization (ESRO).

## Ranger Series Extended

NASA has added five more satellites to its *Ranger* lunar spaceflight series.

The additional spacecraft, designated *Rangers 10* through *14*, will be launched in 1964.

The space agency said no decision had been made as to what payload the spacecraft would carry, but both the retro-rocket delivery system and high-resolution TV cameras in the current program will be considered.

The addition to the *Ranger* program is designed to fill the gap created by delays in the *Surveyor* lunar soft-landing spacecraft program. Originally scheduled for 1963, the first launch in that program has now slipped to early 1965.

Meanwhile, NASA continued preparations for the launch of *Ranger V* last week. Although it was scheduled for Oct. 18, it was possible that weather or technical problems could force a one-month delay.

In another *Ranger* development, NASA disclosed that data obtained during the *Ranger III* flight indicates that the intensity of gamma rays in interplanetary space is probably 10 times higher than anticipated.

## DOD Revising Info Policy

"Deeply concerned at the generally disorderly state" of DOD efforts in the field of scientific and technical information, Deputy Secretary of Defense Roswell Gilpatric has ordered "positive and immediate steps" to correct the situation.

Under the Gilpatric memorandum, issued Oct. 3, the director of Defense Research and Engineering is to develop a comprehensive DOD policy to cover an integrated scientific and technical information program by Jan. 1, 1963.

DDR&E has also been directed to establish a DOD focal point for these activities by appointing a full-time member of its staff as director of technical information. This new office will be responsible for developing and recommending policy and providing coordination and review of the Defense Department's technical information programs.

The three military services and the Advanced Research Projects Agency have been directed to designate individuals within their organizations to provide similar focal points.

"A considerable spur" to DOD efforts to simplify its technical information procedures was provided by Sen. Hubert M. Humphrey's efforts in this area.

As chairman of a Senate government operations subcommittee, Humphrey (D-Minn.), charged last March in a letter to the House Appropriations Committee that between $1 billion and $2 billion annually has been lost by inefficiency and delays caused by improper facilities for exchange of technical information.

He said as much as a year has been added to development programs by the lack of timely information. In the electronics field alone, Humphrey said, $200 million a year is lost because of poor information policies.

While carefully avoiding any dispute with Sen. Humphrey's figures, defense officials said that "it is very hard to substantiate" his charges. "While I do not share the view that our technical or management efforts have suffered as a result of lack of information, a strong presumption exists that the possibility of waste and poor management will eventually ensue," the Gilpatric memo stressed.

## Shots of the Week

Tropical storm Ella abbreviated what was to have been one of the busiest weeks in recent months at Cape Canaveral. Three *Minutemen*, one *Atlas* and a *Pershing* were all cancelled as the storm moved up the Florida coast.

• An Air Force *Titan II* ICBM chalked up its fourth success in six test flights Oct. 12, before the storm closed in. Traveling some 5000 miles down the Atlantic Missile Range, the storable-fueled missile impacted within a predetermined area, according to AF officials.

• *Cosmos X*—another in the Soviet Union's series of unmanned satellites to explore the space environment—was launched Oct. 17. Orbital data was not available but

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early reports indicated the satellite was transmitting normally, had an apogee of 235 mi. and a perigee of 120 mi. Period is 90.2 min.

• Two multi-stage Russian ICBM's were fired into the Pacific Ocean Oct. 17, according to an official announcement that came on the heels of notification by the the USSR of its intention to conduct such tests.

The earlier Tass announcement said "New versions of multi-stage rockets for space objects" were to be tested Oct. 16-Nov. 30.

The rockets were to be fired from the Soviet Union into one of two areas in the Pacific Ocean. The first is a 200-by-400-mi. rectangular area some 2000 miles east of Tokyo and 600 miles northwest of Midway Island.

The second—used by the Soviets for eight similar tests last September and October—is a 100-mile-square area 1000 miles southwest of Hawaii and bordering on the restricted area around the U. S. nuclear-testing site at Johnston Island.

U.S. officials, however, said that the Soviet tests would not interfere with its nuclear testing.

• A two-stage *Apache* sounding rocket carried a 65-lb. payload aloft from Wallops Island, Va., to an altitude of 103 mi. Part of NASA's continuing research program, the Oct. 16 shot transmitted data on ionospheric electron density and temperature. There were no plans to recover the payload from the Atlantic Ocean.

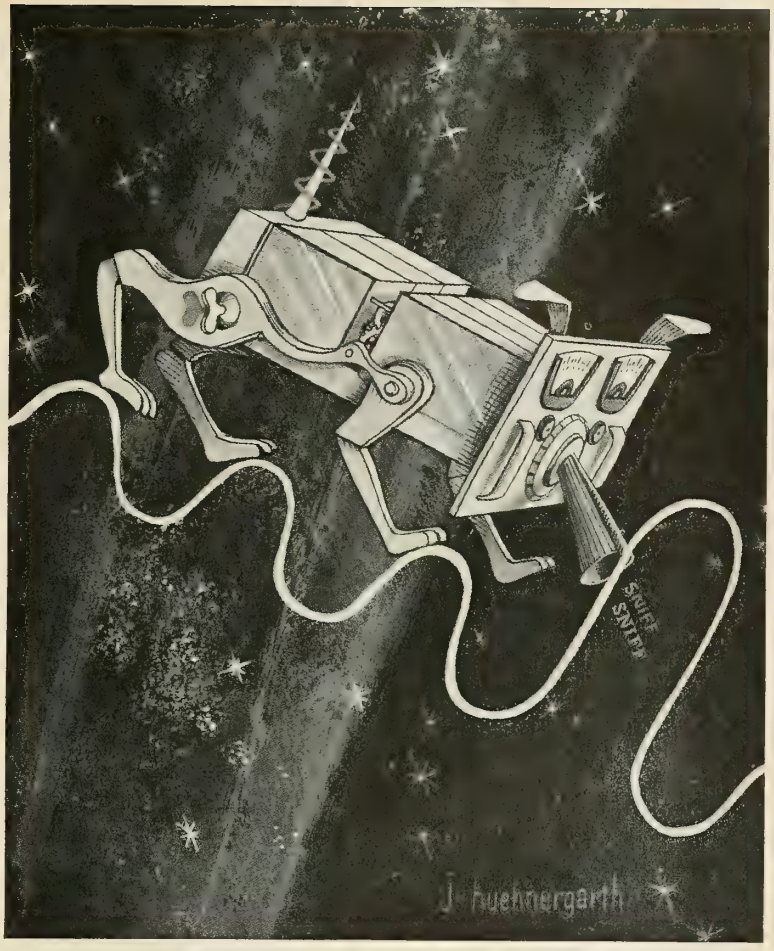
• A *Thor* missile carrying a submegaton nuclear device malfunctioned "within minutes after liftoff" Oct. 16, and both the nuclear device and the booster were destroyed over Johnston Island in the Pacific. The third failure in four attempts, the test was part of the U.S. high-altitude nuclear test series. Cause of the failure was not revealed. Another test was reportedly scheduled for Sept. 20.

## IAS-ARS Merger Pending

The governing bodies of the Institute for the Aerospace Sciences and the American Rocket Society have approved merger of the two groups into the American Institute of Aeronautics and Astronautics.

The council of the IAS and the board of the ARS approved the proposed merger Oct. 14.

The agreement will be submitted to members of the two societies for ratification. Full information on the proposal and the necessary legal documents will be sent with ballots to members of both groups in about two weeks.


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*After NASA review . . .*

# Apollo Guidance Costs Under Control

***Overruns traced to space agency's first work statements, prepared on crash basis***

**by Charles D. LaFond**

SOARING *Apollo* guidance and control cost estimates are now being brought back to Earth.

The present rhubarb, according to both NASA and industry officials associated with the program, can be traced directly to NASA's first "detailed" *Apollo* work statements which necessarily were prepared on a crash basis following subcontractor selection early this year.

Considering the tasks contemplated, say the subcontractors involved, initial work statements upon which proposals were based were extremely general and brief. Bidders used these specifications to provide NASA with a usable definitive contract base. This hastened contractor selection and still gave bidders an equal opportunity since all were made on the same information.

Apparently trouble arose with the next work plans, prepared by MIT's Instrumentation Laboratory—*Apollo* guidance system prime contractor—and NASA. As an industry spokesman put it: "They started out to buy a car and established a budget for it. Then they ordered power steering, power brakes and a host of other extras not originally desired. Result was a bill far exceeding the planned budget figure." After contractor selection, *Apollo* systems and schedule modifications were in a constant state of flux.

• **Holmes comments**—NASA's Moon boss, D. Brainerd Holmes, told M/R last week that cost overruns in Project *Apollo* "are giving us some very severe problems."

"Many of the current cost estimates of our contractors," Holmes said, "are above their original bids."

He asserted that he was working with the contractors during current negotiations to stress the real budgetary limitations controlling the manned lunar landing program. "In every case," he said, "they have been very cooperative. They have not just paid lip service, but have made real efforts to cut their costs."

M/R requested comment from Holmes after disclosure that space agency officials were concerned by the rising cost of Project *Apollo* (M/R, Nov. 8, p. 16; Nov. 15, p. 13).

A NASA official originally told M/R estimates submitted by some of the industrial support team were "shocking".

Holmes refused to describe the situation as shocking, but he acknowledged that some of the cost estimates in the guidance area are considerably higher than the original bid. He said not all of the guidance contractors were involved.

One reason for the cost overruns, Holmes said, stems from the very nature of cost-plus-fixed-fee contracts, in which firms may tend to be overly optimistic in their original estimates.

Industry misunderstanding of technical requirements and NASA's penchant for changing its mind on specifications are other pertinent reasons for the higher costs, Holmes added.

Other NASA officials queried by M/R declined to comment, explaining that current negotiations preclude further discussion of *Apollo* contracts.

• **Industry view**—When one typical G&C subcontractor ended up with a cost estimate two and one-half times its original contract figure and another was even higher, NASA's top management roared.

In defense of its cost estimates, one contractor then prepared an item-for-item comparison of work requirements vs. cost between the first and second work statements. The result: cost of similar items were roughly equivalent, but where item quantities had been increased and extras had been added, costs were significantly higher.

In one case, 28 complete ground-support systems were called for—greatly exceeding the number of space vehicles to be built.

There appear to be two distinct schools of thought in NASA concerning support equipment. One calls for a centralized integrated checkout concept involving an extremely impressive ground computer complex. At the same time, NASA specs call for a massive supply of GSE from individual subcontractors. The result, contractors say, is duplication of costs, and other parallels in *Apollo* subsystems are driving costs even higher.

Reliability definition and test requirements are considered by some to have been completely unrealistic. Also, spare parts requirements have been the subject of steadily changing ground rules, and requirement changes have resulted in boosted costs.

Still further, subcontractors complain that the number of contractor support personnel required to "live in" at MIT is too large—adding to subcontractor costs without providing a fair return.

Other strong disagreements still exist within NASA as to major technical approaches concerning G&C. According to a subcontractor's spokesman, "They still disagree on whether to go fully automatic with pilot override or reduce system complexity to make maximum use of pilot control capability."

• **The situation today**—At the working level, NASA, MIT, North American Aviation and sub-contractor participants believe problems of technical requirements and costs are being solved amicably and practically. "We were unaware that any serious disagreement existed," said one official, "until NASA leaders spoke out."

When both sides realized that prohibitive costs had evolved, each set out constructively to trim nonessentials from G&C requirements. NASA and MIT now have produced a new, definitive work statement.

Under current requirements, one subcontractor whose cost estimates were notably high now says it can come within $1 million of its original bid.

Others say they can match original prices item for item—but their expanded requirements indicate that overall costs will fall somewhere between their first and second cost estimates.

All principal subcontractors on the G&C effort now are involved in a NASA review and re-evaluation of their tasks. Contract negotiations will continue for the following major G&C subcontractors over the next several weeks:

Minneapolis-Honeywell (sub to NAA for stabilization and control system and flight control systems integration); AC Spark Plug Division of General Motors (inertial guidance platform and associated electronics); Raytheon Co. (guidance computer); Kollsman Instrument Co. (optical subsystems). ¤

***Backup possible . . .***

# NASA Firm on Lunar Orbit Choice

**by Hal Taylor**

TOP NASA officials are sticking to their decision to use Lunar Orbit Rendezvous for the first U.S. manned lunar landing despite pressure from White House science advisers.

It is possible, however, that NASA may develop a backup method calling for Earth-orbit rendezvous utilizing a *Gemini* spacecraft.

D. Brainerd Holmes, the space agency Moon chief, told MISSILES AND ROCKETS NASA is finishing its evaluation of LOR and has not changed its mind on its feasibility.

The program, he said, will move ahead with the award of contract for the Lunar Excursion Module of the *Apollo* spacecraft. "We hope to make the award within a month," Holmes said.

Holmes' comments followed continued reports that the top White House science adviser, Dr. Jerome Wiesner, bitterly opposes the LOR decision.

Holmes refused to comment on the reports, but did say that NASA's Office of Manned Space Flight is keeping Wiesner informed of its findings.

Under the LOR concept, the three-man *Apollo* spacecraft would be launched from the Earth by an *Advanced Saturn* booster into orbit around the Moon. The two-man LEM would then detach itself and descend to the lunar surface. After exploration, the LEM would launch off the Moon and rendezvous with the orbiting command and service modules for return to Earth.

One argument presented by opponents of LOR is that rendezvous in Earth orbit (EOR) would be safer than LOR and would also provide more fallout for U.S. military space program.

Holmes described this as a "specious" agrument. He said "we have never been able to get DOD to say that."

Other opponents, reportedly including Wiesner, have claimed that a direct flight with a lighter two-man spacecraft could cut as much as two years off the U.S. target date for a manned lunar landing. McDonnell Aircraft Corp. and Space Technology Laboratories have been conducting studies of its feasibility. The McDonnell plan would involve an extensively modified *Gemini* spacecraft.

Another well-informed Administration official told M/R that of the three possibilities—LOR, EOR, or direct flight with a two-man capsule—the latter is the least feasible.

He said as far as he is concerned the LOR decision has been made.

He said that it is possible that NASA may approve a backup method for the lunar landing which would involve mating a modified *Gemini* spacecraft with a booster in Earth orbit.

The official noted that the U.S. will be practicing Earth-orbit rendezvous in the *Gemini* flight series, and it is possible this could be extended for the lunar landing mission. ⌗

## Dryden Details Deep Difficulties with Centaur

SIX MAJOR PROBLEMS continue to threaten scheduling, performance and funding of the *Centaur* launch vehicle program.

The new troubles for the already long-delayed liquid hydrogen upper-stage program were discolsed by NASA in a report to the House Space Committee.

The space agency said that the problems can be solved only through intensified effort by both NASA and its contractors.

The report was made in a letter from Deputy Administrator Dr. Hugh L. Dryden to the committee chairman, Rep. George P. Miller (D-Calif.). It stemmed from a committee investigation of the liquid-hydrogen upper-stage program following the unsuccessful first launch of *Centaur* on May 8, 1962.

The problem areas detailed by NASA:

—Capability of the *Atlas* and *Centaur* to carry heavy payloads under severe wind conditions must be studied in greater detail to assure that adequate margins exist. Existing reports and test results indicate satisfactory capabilities, but studies in greater depth are desired.

—Though overall quality of fabrication work on *Centaur* has improved since the prime contractor—General Dynamics/Astronautics—gave it project status in February 1962, added improvement is required to reach the level of quality control desired for a vehicle of this type.

—The guidance system will require further development effort to achieve necessary accuracy with good reliability.

—Tank fabrication will call for better welding techniques, somewhat heavier metal in weld areas and investigation of better steels for use at liquid hydrogen temperatures. An intermediate bulkhead problem noted previously, however, appears to have been substantially solved by the application of similar techniques in that area.

—Separation of *Centaur* from *Atlas* in flight requires further analysis—and possibly some changes—to achieve a sufficiently high probability of clean separation.

—The nose cone and insulation panels, redesigned following the first flight, must be fully reviewed and tested to prove their capability to withstand the aerodynamic load encountered.

• **'65 target**—Despite the new problems, NASA said there is still a good chance successful *Centaur* development will permit the first launch of the *Surveyor* lunar spacecraft no later than early 1965.

The report said that about $100 million will be spent on *Centaur* in Fiscal 1963 to accelerate development. Other NASA officials indicated that at least that much will be spent in Fiscal '64. The same officials also said NASA still is considering a DX priority for *Centaur*, but the decision will be made by the Kennedy Administration.

The report also included further details of studies of possible new launch vehicles for *Centaur*. The studies will be conducted by Lewis Research Center, which recently acquired program responsibility for the upper stage.

The report said that Lewis will study use of the *Titan II*, *Saturn C-1* and *Saturn C-1B* vehicles as a first-stage booster.

The space agency noted that *Titan II/Centaur* offers considerably better performance over *Atlas/Centaur*. It added that *Centaur* on the *Saturn C-1B* offers a major increase in payload capability—which will be required for advanced planetary missions in the second half of this decade. ⌗

# Sec. McNamara Outlines Defense Dept.

***Next three months will bring decision on how high military space funding will rise; Titan III progress praised; no 'clear' man-in-space requirement***



**SECRETARY McNAMARA:** *". . . we must be prepared to put man in space . . . should new requirements develop."*

*IN THE accompanying interview, Secretary of Defense Robert S. McNamara states for the first time some of his views on the role of the military in space—and how the role may develop in the future.*

*The interview, and a recent speech by Assistant Defense Secretary John H. Rubel (see p. 37), indicate that the official Pentagon attitude toward military space activity has become, for the time being at least, more favorable than might have been gathered from previous, fragmentary DOD pronouncements.*

*In general, the Secretary states that while he sees no "clear" military space requirement now, DOD is keeping an open mind.*

*(See editorial, page 46.)*

**Q**—*Is there any increase planned in the military space program?*

**A**—The military space program of about $1.5 billion in Fiscal Year 1963 is about twice last year's level and about three times the level of Fiscal Year 1961. Because of the lead time in converting obligational authority into expenditures there will necessarily be an increase in expenditures in Fiscal 1964. There has been no decision yet on the new appropriations to be requested for Fiscal 1964. We'll be making such decisions in the next 90 days as we prepare the Fiscal 1964 budget.

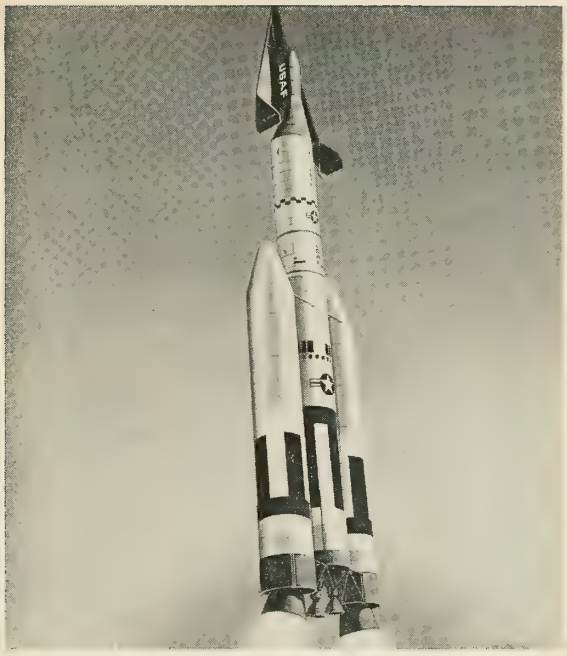
**Q**—*What is the military role in space? What weapons in space do you foresee?*

**A**—The requirements for specific military operations in space are not completely clear. Our research and development program is exploring the techniques and the technology, and when and if specific requirements for military operations in space are determined, we will be prepared to apply these developments. As an example of this approach, we know we would need larger boosters if our operations in space expand beyond the projects that we are currently conducting in communications, navigation, weather, mapping and similar applications. Therefore, the development of a large booster program was the first thing we attacked last year. President Kennedy in his amendments to the defense budget for Fiscal 1962 asked for and obtained $62½ million for large booster development as a foundation for whatever military operations in space might be required in the future. That led to the *Titan III* booster, an $808-million project which was announced recently. I am very pleased with the progress of *Titan III*. It is a very important building block for any expanded space program. If by any chance we need to develop manned operations in space, we would have the boosters for the larger satellites that would be required.

**Q**—*What is the military requirement for manned satellites?*

**A**—I am not prepared to say that we will or will not need to have manned spacecraft. I cannot read the future. But we are acquiring the necessary knowledge and techniques that will be required if we find we have to put man in space for military operations. We are developing the big boosters, we are supporting the *X-20* to develop maneuverable re-entry from orbit, and we are carrying forward the studies in bioastronautics to give us the capabilities of placing a man in space for an extended period of time. We expect to spend very close to $1 billion on the *X-20* developing manned space flight and controllable landing capabilities. These are the types of equipment we need to support manned operations in space.

# Plans for Space



**X-20 ATOP TITAN III**—*$808 million for the booster, nearly $1 billion for maneuverable re-entry.*

At this time I see no clear requirement for manned satellites for military purposes. Trying to put a man into the space vehicle leads to complications and delay. For example, many extra months of development work are required to "rate" a rocket for manned flight, i.e. to increase its reliability sufficiently to entrust a man to it. At present, we can do almost everything we need to do without a man in the satellite. Much of what we need to do now we can do better without man—and sooner. But we must be prepared to put man in space in the future should new requirements develop. It is for this reason that we are developing the large boosters, the experience in the space environment and the techniques associated with potential military operations in space.

**Q**—*Do you favor the Air Force proposal for a manned orbital development system—a manned space station for experimental purposes?*

**A**—I would favor it if it adds anything substantial to what we are already doing in *X-20* and the NASA *Gemini* and other programs.

**Q**—*Has the Air Force made such a proposal for Fiscal 1964? The Air Force space program was scheduled for presentation to you Oct. 1.*

**A**—I believe the Air Force probably will need more time to complete the proposal. It has not yet been presented to me.

**Q**—*Has the Advent space communications system been abandoned?*

**A**—It has not been abandoned but it has been substantially reoriented. In its original form, the program was quite unsatisfactory. We are now exploring alternative ways of developing communication satellites. The Army, Air Force and the Defense Communications Agency are cooperating in this project.

**Q**—*Is there a clear-cut definition of what area the military communications satellite program would cover?*

**A**—The military communications satellite system would be for very specialized defense purposes. It would not have the traffic capacity required of commercial communications satellites, but it would cover a broader area of the world and would have to be jamproof and highly reliable. Certain of the requirements would have to be more stringent than for commercial uses.

**Q**—*Is there a threat in space from enemy satellites carrying super-megaton bombs?*

**A**—It is difficult to see any advantage in such satellites. ICBM's and submarine-launched missiles are already an existing threat and such weapons appear as effective as a bomb-carrying satellite and substantially less costly.

**Q**—*Are the Russians building bigger rocket boosters of the kind that would take them to the Moon?*

**A**—I know of no indications that they are building bigger boosters. But it would be unwise to assume they are not. They have the capability to build bigger boosters and we must assume they may try to do so.

**Q**—*Are the Russians developing more advanced generations of ICBM's?*

**A**—We have no such information of such programs but because they have a capability to improve their weapons we must assume they are doing so.

**Q**—*What are we doing to improve our ICBM's now that the early Atlas missiles are becoming obsolescent? What is beyond the Minuteman ICBM?*

**A**—We will go into that in our review of the Fiscal 1964 budget and the five-year program. It is reasonable to assume we will continue to introduce improvements and advances into our weapons systems.

**(The above interview with *Newsweek* Pentagon correspondent Lloyd Norman is printed by special arrangement with *Newsweek* magazine.)**

# Congress May Ride Close Herd

***House committee, regardless of its leadership, seen likely to keep close watch on programs***

**by Frank G. McGuire**

SUCCESS of committee investigations into the *Centaur* and *SNAP-50/SPUR* programs may prompt increased congressional interest in other phases of the nation's space program.

Action by the House Space Committee (M/R, Oct. 8, p. 15) and the Joint Committee on Atomic Energy (M/R, Sept. 24, p. 14) resulted in shuffling of management on the two programs, whetting congressional appetites for future improvements.

Furthermore, a series of recent developments within the House Space Committee may accelerate the rate at which the next Congress will probe specific programs.

Under chairmanship of the late Rep. Overton Brooks (D-La.), the Space Committee undertook most of its business as a body. With direction of the committee now in the hands of Rep. George P. Miller (D-Calif.), significant changes have been made that guarantee deeper probing into space-program management.

Miller's establishment of subcommittees enables Congressmen to look more specifically into various aspects of the national space effort, and allows younger Congressmen to become more familiar with the problems and accomplishments of the agencies involved.

It was such a subcommittee that prompted re-evaluation of *Centaur's* management and caused NASA to move the project to Lewis Research Center from Marshall Space Flight Center.

• **Interested leadership**—Chairman Miller, who will very likely remain in his post throughout the next session, is reported to be planning retirement after the 88th Congress. But the 71-year-old Californian will not confirm these plans and his office denies knowledge of them.

Miller's retirement after the next Congress would leave the chairmanship to Rep. Olin E. Teague (D-Tex.), who is also chairman of the Veterans Affairs Committee. Since he cannot hold two committee chairmanships simultaneously, Teague would have to vacate one. Congressional observers believe he would prefer to serve on the Space Committee.

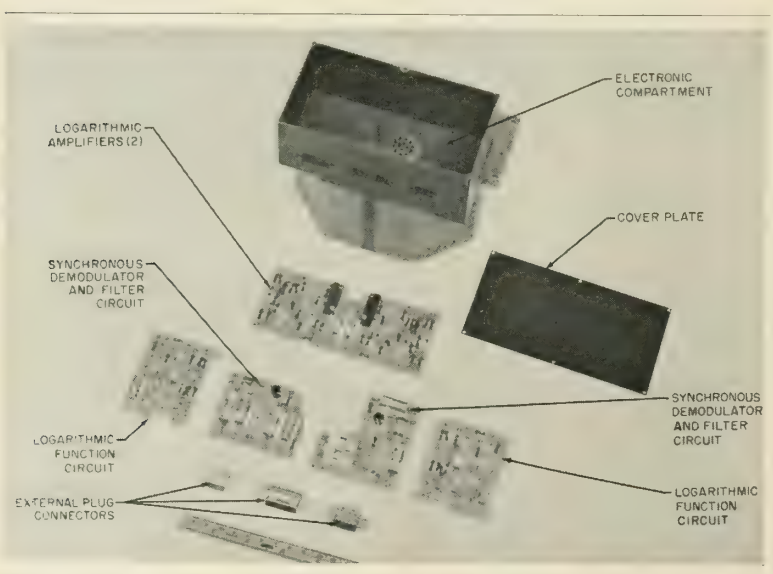
Teague's record of interest in the space program points to increased delving by the committee into space-management problems.

In the unlikely event Teague declined committee chairmanship, it would pass to Rep. Joseph E. Karth (D-Minn.), whose record includes chairmanship of the subcommittee hearings that resulted in the *Centaur* shuffle.

• **Boost for AEC**—Strong backing for the Atomic Energy Commission as a third space agency came from the Joint Committee on Atomic Energy. The *SPUR/SNAP-50* hearings gave the AEC a firm voice on design of spacecraft using nuclear power.

The JCAE feels AEC's lack of a need to prove "requirements" before a system can be developed will circumvent the snags encountered by programs such as RS-70, *Dyna-Soar* and *SNAP-50*. Pointing to AEC support of the nuclear rocket when Air Force had virtually withdrawn for lack of a requirement, congressional sources feel AEC will be able to go ahead with many basically sound developments for which there is no established need.

Senate leaders give little indication that hearings will be held on the Administration stand on military uses of space, despite the precedent set by the RS-70 hearings. ⌗




## How Radiometer Will Function on Mariner II's Fly-by

*FIVE CIRCUIT BOARDS hold major electronic components for IR radiometer riding aboard NASA's Mariner II, due to pass in the vicinity of Venus Dec. 14. The two-channel instrument, developed for JPL by Barnes Engineering Co., will attach to the spacecraft's microwave antenna to take measurements of both planet radiation and background space environment—the latter as an absolute temperature reference. Instrument design allows measurements between 200°K and 600°K, with ability to detect differences as small as 2°K at the low temperature extremes. Radiant energy collected by the two channels is fed to independent germanium-immersed detectors, then amplified and compressed. The analog signal output is converted to digital form before being telemetered. The channel aimed at Venus has an 8-9 micron passband. The other channel is filtered to a 10-10.8 micron bandwidth. Outputs from each channel go to separate leads and are sampled once every 20 seconds for 5 milliseconds.*

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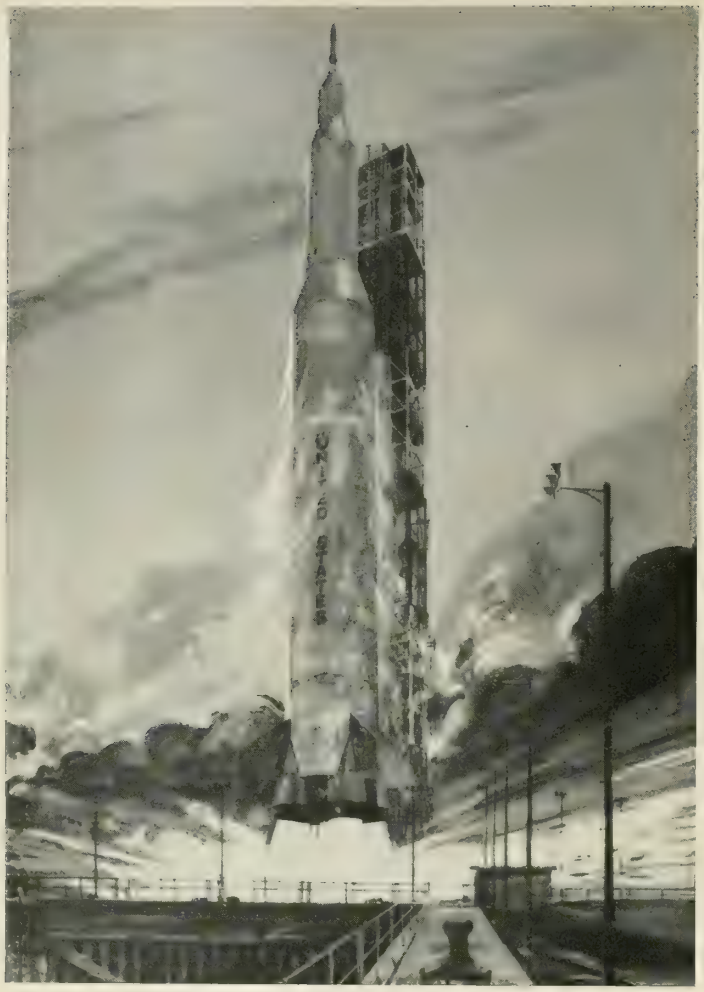
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2) Have you ever been arrested (except traffic and juvenile)?

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|---|---|---|
| 1. | | |
| 2. | | |




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| 2. Position & Duties | | |
| 3. Position & Duties | | |
| 4. Position & Duties | | |

REFERENCES. Give full names, occupations and addresses. Professional (previous supervisor preferred):

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# Technical Countdown

## ELECTRONICS

### Only Five Basic Circuit Functions Needed

Eighty-five percent of the supporting flight electronics for inertial guidance systems could be handled by only five different standard electronic functions, according to experts at Autonetics Div., North American Aviation. An intensive study by the division seeking to standardize circuit functions led researchers to limit required functions to a general-purpose amplifier, synchronous switch, power gate, flip-flop and logic gate.

### Sun-pumped Laser Successful

First direct conversion of sunlight into a coherent infrared beam has been accomplished by scientists at RCA's David Sarnoff Research Center, Princeton, N. J. In its experimental system, RCA used a 12-in. hemispherical mirror for focusing the solar energy at a calcium-fluoride crystal laser. The laser was liquid-neon-cooled. About 50 watts input produced a continuous-output IR beam at a wavelength of 2.36 microns.

### G-20 to Aid Ionosphere Study

A Bendix Corp. G-20 computer will join the huge Wullenweber radio direction finder of the University of Illinois in a continuing study for the Navy of the Earth's ionosphere. The G-20 is expected to enhance data handling because of its extensive memory and processing speed. The 120-pole Wullenweber array—65 ft. high and 995 ft. dia.—has been operating for three years and is now reported to be accurate to less than 0.25°.

### UK to Expand Meteorological Net

Over the next year and a half the British will install a new meteorological radar network to obtain wind speed and direction data up to 100,000 ft., according to the Air Ministry. Cossor Radar & Electronics Ltd. will supply 12 radars at a cost of more than $2 million.

### Milky Way Radio Waves Measured

University of Michigan radio astronomers have measured the intensity of low-frequency radio waves in the Milky Way with a 145-lb. instrument package boosted 1050 miles into space from Wallops Island last month. Interpretation of the data will take several months, but researchers hope to find exact location of an expected drop-off in electromagnetic radiation intensity with decreasing frequency. If found, the decrease should reveal presently unknown physical properties of the Milky Way and may help clarify theories concerning the origin of the star system. Standard radio astronomy techniques are blocked from such measurements by the Earth's ionosphere.

### Solar Thermo-converters for Space Power

Wafer-thin solar thermoelectric panels perfected by General Atomic Div., General Dynamics, will be checked out aboard an experimental package to be launched from Vandenberg AFB later this fall. The flat panels consist of many thermoelectric elements sandwiched between two thin metal sheets, one a collector the other a radiator. Each panel will produce 0.25 watts when exposed to full sunlight. The devices have a high degree of radiation resistance because of the low-purity levels in thermoelectric materials.

### Thermi-Thermo Cascaded Successfully

A cesium thermionic-thermoelectric cascade generator has been built and operated by scientists from Thermo Electron Engineering Corp. and Minnesota Mining and Mfg. Co. The thermionic generator, in the shape of a tapered plug, fits inside the thermoelectric generator. Waste heat rejected from the thermionic unit operating at 1440°C passes directly to the hot junction of the thermoelectric generator at about 500°C. Overall power output was 15 watts with an efficiency of 7.3%. A thermal loss between the generator surfaces in the experimental unit prevented full capacity operation. Thermo Electron built the thermionic unit while 3M developed the thermoelectric generator.

## PROPULSION

### Blue Streak Still on Schedule

Despite reduced funding and the lack of military requirements, de Havilland reports its *Blue Streak* space booster is on schedule. Developers are touting system reliability after its highly successful 16th static firing at Spadeadam last month. *Blue Streak* is scheduled for first flight at Woomera late in 1963, and the first European satellite is to be launched in 1966.

### $LH_2$ Sub-Cooled By Helium Gas Injection

Prelaunch problems with hydrogen-propelled vehicles, caused by environmental heating in the delivery tubes, may be eliminated by bubbling helium gas through the lines. Alan Schmidt, National Bureau of Standards, Cryogenic Engineering Labs, Boulder, Colo. investigated the technique under NASA sponsorship. Evaporating helium sub-cools the hydrogen sufficiently to provide a delivery pump with properly conditioned fluid—avoiding pump cavitation and the chance of faulty combustion. Previous studies at Marshall Space Flight Center showed the technique to be effective with liquid oxygen.

## LIFE SUPPORT

### G Forces Produce Phosphene

Subjects undergoing head-to-toe acceleration in the University of Southern California's human centrifuge experienced sensations of light and color when completely blindfolded. According to Dr. P. R. Tobias of Aerospace Corp., all riders "saw" the phosphene at about 3.6 G's. Reports on its appearance were in close agreement as to form and color. The discovery suggests that pilots may "see" phosphenes in dimly lit cabins and may mistake these for actual lights. Sixty runs were made with each subject wearing a light-tight mask. All experienced the phenomenon.

# Spy Satellites Hit Technical Snags

***Better discrimination capability required; Northrop simulation of celestial environment may provide solution***

**by William Beller**

SATELLITES for ballistic-missile early warning and surveillance of space targets are running into technical questions similar to those encountered in the Navy's antisubmarine-warfare problem—and equally intransigent.

The difficulty in space is to develop systems sensitive and versatile enough to single out potential targets from the background "noise" of Earth, atmosphere and sky. To help solve this problem, Northrop has begun a program to simulate the celestial environment.

A further complication in space is the need to find targets within a relatively short time span; on the other hand, there is no barrier such as water to prevent "seeing."

• **Much money**—The Defense Department earlier this month admitted it was having trouble in its effort to erect surveillance satellite systems. Assistant Secretary of Defense John H. Rubel said $300 million has been spent on a *MIDAS*-type (ballistic-missile early-warning) system "despite great technical difficulties and disappointments." He added that $100 million more will probably be spent for further developments in this fiscal year.

About $40 million is known to have been budgeted this year for the anti-satellite inspection system now called *Satellite Inspector*—formerly *SAINT I*. This program was to be ready for feasibility demonstrations this past April, but has already slipped at least six to seven months.

Only the reconnaissance satellite *SAMOS* is operational or close to it. DOD reportedly is getting data from this system.

• **Detection and classification**—The *Satellite Inspector* will use television cameras as optical sensors. These, together with a means for separating satellites or missiles from the background, make up the detection system.

The classification problem has to consider the ephemeris of all known circum-Earth space objects; moreover, the problem of recognizing and disregarding decoys has to be solved before an offensive *Inspector* can be developed.

The system will undoubtedly have feed-ins from ground-based systems such as SPADATS (Air Defense Command's Space Detection and Tracking Systems); in turn, the system will feed SPADATS.

The *Inspector* probably will generate data in ground-based computers of its own: there appears to be no other feasible way to store and compare standard celestial patterns with those glimpsed by the *Inspector*—a potential target would be any object seen by the *Inspector* but not in the standard patterns.

• **Simulation work** — The celestial inputs needed for space observational systems and the techniques for getting them were outlined in a recent study by L. L. Collins and R. B. Freund of Northrop Space Laboratories. Their work is part of a plan to simulate the celestial background perceived by spacecraft sensors seeking possible space targets or points for space navigation.

The work is in an early stage. The dynamic celestial backgrounds studied are those seen by an observer in a circular orbit coplanar with a target—a satellite or newly launched missile. Future plans call for removing the coplanar and circular orbit restrictions.

Earth, atmosphere and lunar backgrounds will also be investigated, simulated and coupled with the celestial background for composite dynamic background computations.

The reason is that sometimes a satellite observer watching the flight of a ballistic missile will have only Earth in his field of view; at other times, the view may lift to include the atmosphere and then the stars. Most often, however, the observer will see the three backgrounds at differing times and possibly the Moon, particularly when the target is another satellite.

• **Celestial backgrounds**—Stars, star groups and nebulae, and solar-system objects comprise the celestial backdrop for finding potential targets.

The star groups, galaxies and nebulae complicate the discrimination problem because of their finite angular size and the variations in brightness across the observed disk. Northrop reports that isophotal contour studies are being made of these celestial objects brighter than the eighth magnitude. The results will be included in the simulation program.

The planets may also be part of the observed celestial background. Collins and Freund say they are studying equations for obtaining approximate values of the planetary intensities observed from a space vehicle as functions of their phase angles, ranges and time. Appropriate lunar and solar characteristics are also being studied, the scientists say.

Simulations of the Sun, Moon, planets and stars comprise the proposed celestial-background program.

• **Stars major concern**—The stars are the most important units because they are the most numerous space objects; the Northrop study therefore puts primary emphasis on simulating the stellar background.

The initial problem is to determine the position, visual magnitude and spectral class of each star within the observer's field of view. The Boss star catalog, available on IBM cards, was selected for use in the simulation studies because it includes the needed information for all stars brighter than eighth magnitude—approximately 33,000.

Northrop is developing computer programs that employ binary tapes of the Boss catalog to extract data on the stars within the boundaries of a given field of view; the amount of data taken is limited by the presumed sensitivity

of the observing system. Inputs to these programs are the direction of the optical axis of the observing system plus the boundaries of the desired portion of the system's field of view. All these data will be stored and used in the simulation program.

For a satellite inspector, the stored data would be continuously compared with the sky views observed: any foreign object would automatically be noted and analyzed.

• **Coordinates of a star**—In the system, stellar position is given in terms of declination—the arc from the celestial equator to the star measured along the great circle passing through the star and the celestial poles, and right ascension—the arc from the vernal equinox eastward to this great circle.

• **Star brightness**—The brightness of a star is measured in terms of a "magnitude" scale—a logarithmic division in which five brightness units represent a brightness ratio of 100. Each step in magnitude, therefore, is equivalent to a step in brightness of 2.512—the fifth root of 100.

Originally, stars were classified from the first to sixth magnitude, where the sixth represents the perceptiveness limit of the unaided eye. But the current magnitude scale includes zero and negative numbers: Venus is −4, 10,000 times brighter than a sixth magnitude star; the Sun is −27.

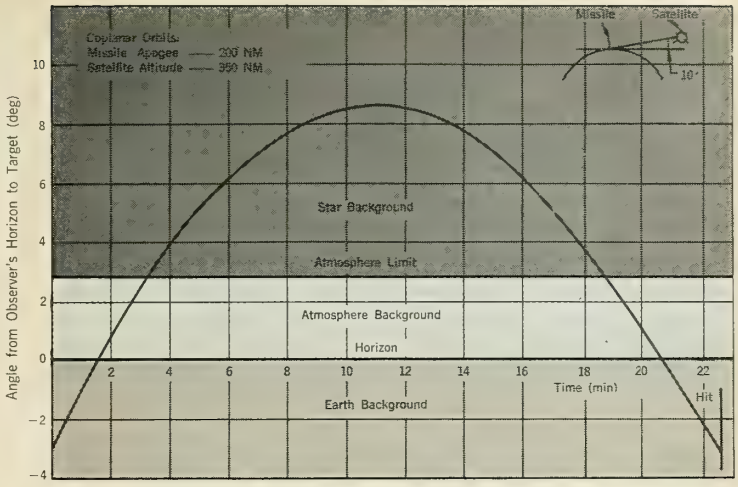
Approximate number of stars brighter than a certain magnitude: sixth, 1620; tenth, 324,000; fifteenth, 32-million; twentieth, 1-billion.

• **Star classes** — Stars are usually grouped according to the characteristics of their spectra. These, in turn, are a function mainly of stellar atmospheric temperatures.

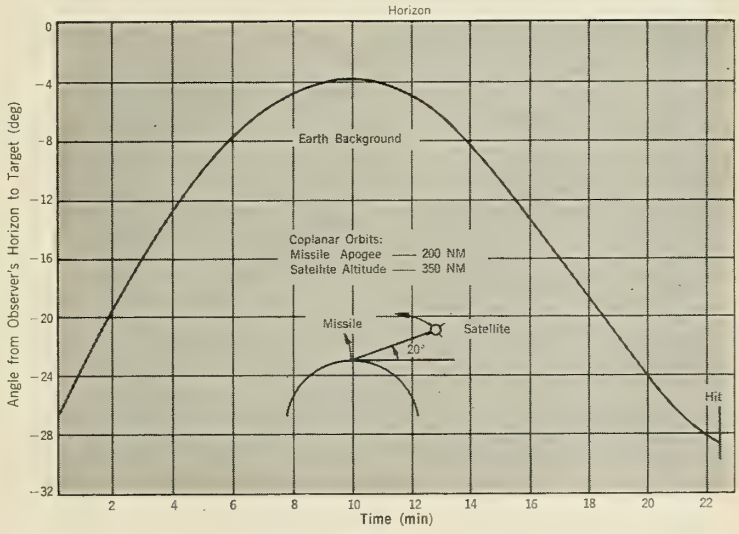
Arranged in terms of decreasing temperature, the spectral classes are in the sequence O-B-A-F-G-K-M—perhaps remembered with the aid of the mnemonic: Oh be a fine girl, kiss me! In addition to this main sequence are classes R, N and S—relatively cool groups of stars in which appear the molecular spectra of hydrocarbons and cyanogen.

The higher the star class, the more strongly ionized are the atmospheres of its members: in class O, for instance, helium is ionized; class B, helium is neutral; class A, weak metallic lines appear; class F, the metallic lines are stronger; class G, our Sun's spectrum appears; classes K and M, hydrogen and potassium lines are very strong.

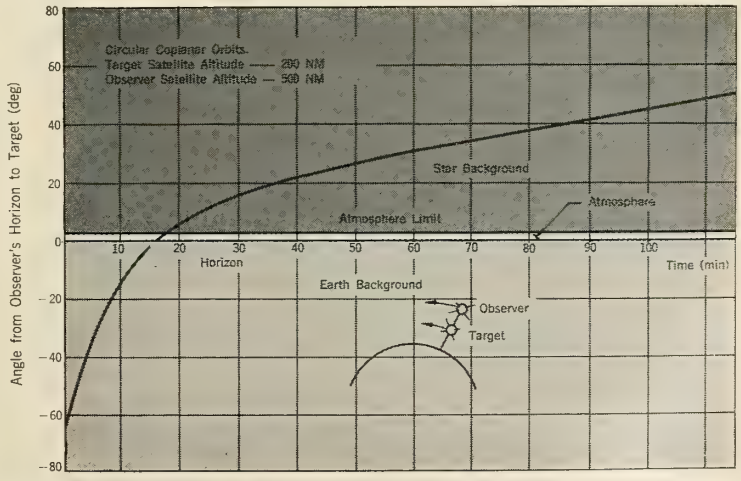
Clearly, there is no lack of sky data for a satellite inspector or spacecraft navigation system to use. What is difficult is deciding on practicable sets of sensors and logic circuits. ⌗




*DYNAMIC BACKGROUND—observer 10° above launch-site horizon at launch time.*

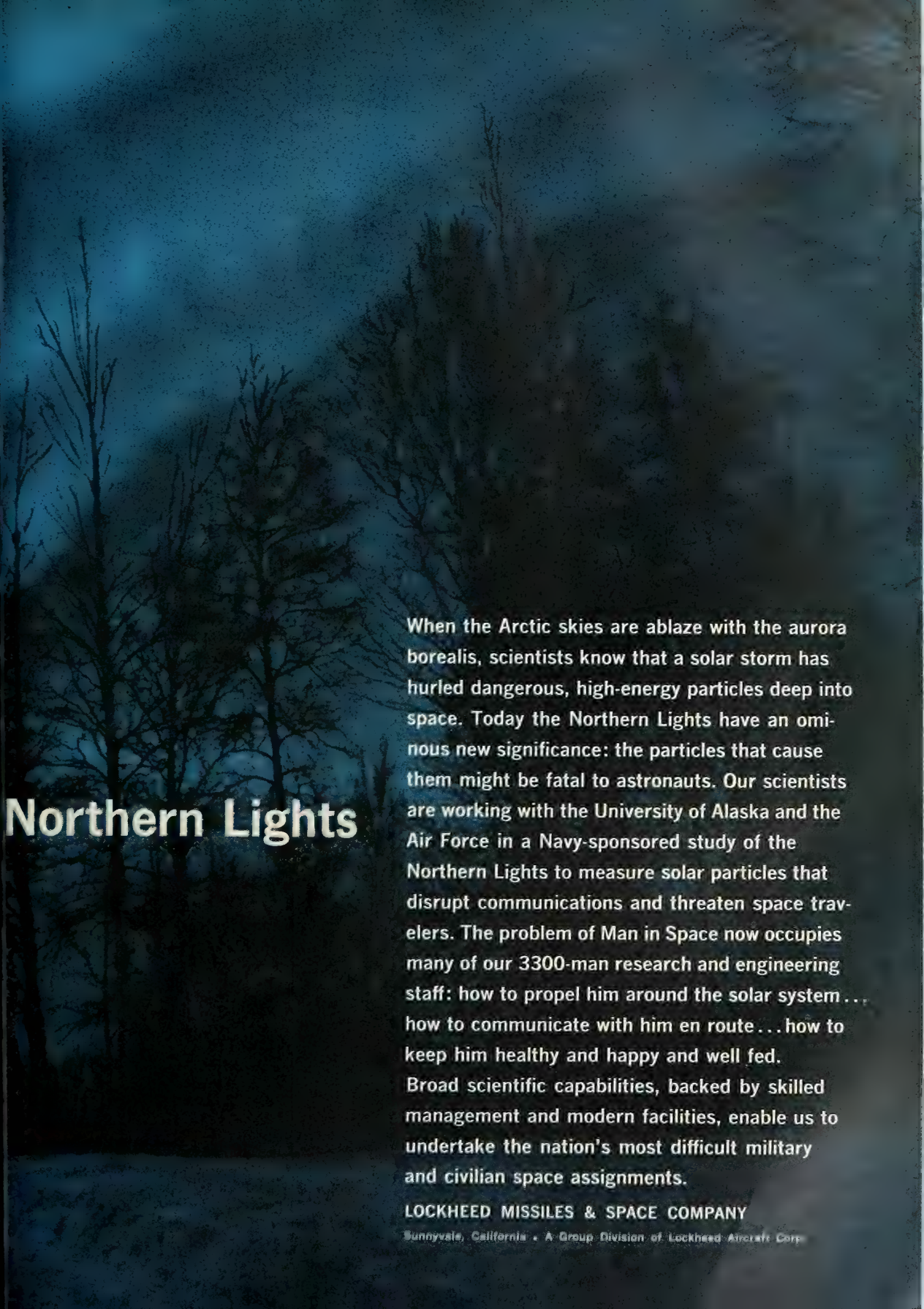



*DYNAMIC BACKGROUND—observer 20° above launch-site horizon at launch time.*




*DYNAMIC BACKGROUND—observing satellite initially directly above target satellite.*


The new significance of the



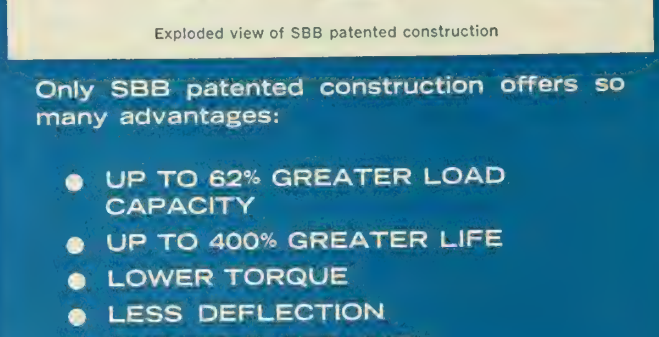
# Northern Lights

When the Arctic skies are ablaze with the aurora borealis, scientists know that a solar storm has hurled dangerous, high-energy particles deep into space. Today the Northern Lights have an ominous new significance: the particles that cause them might be fatal to astronauts. Our scientists are working with the University of Alaska and the Air Force in a Navy-sponsored study of the Northern Lights to measure solar particles that disrupt communications and threaten space travelers. The problem of Man in Space now occupies many of our 3300-man research and engineering staff: how to propel him around the solar system... how to communicate with him en route... how to keep him healthy and happy and well fed. Broad scientific capabilities, backed by skilled management and modern facilities, enable us to undertake the nation's most difficult military and civilian space assignments.

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# Syncom Satellites:

## S-Band Frequencies Viewed as Key Link

UTICA, N. Y.—Two IBM scientists report that the low and middle S-band (1.5-5.2 Gc) microwave frequencies may be more feasible than either millimeter or optical wavelengths for linking synchronous-altitude satellites.

Many observers believe it is preferable to use microwaves for many satellite-to-satellite communication links where security is not essential. They contend that this method is at present superior to higher-frequency systems—primarily because of the stabilization tolerances presently achievable in satellites.

A paper by Dr. C. M. Johnson and Kenneth E. Neibuhr of IBM's Communications Center in Rockville, Md., points out that nominal beamwidth tolerance for an S-band system at ranges of roughly 45,500 miles (the estimated distance between two synchronous-altitude ComSats) would be about 4 deg. At the higher frequencies the angle narrows considerably: to about 1 deg at X-band, 3 minutes of arc in the millimeter region, and 10 seconds of arc with optical frequencies.

The Johnson-Niebuhr paper, presented at the IRE's 8th National Communications Symposium here, also reports that studies of galactic noise show a preference for system operation above 1 Gc, and that transmitter power and antenna size requirements favor operation above 2 Gc.

Building the case for S-band as most feasible within the microwave region, the authors report that favorable tradeoffs can be made in antenna size versus increased transmitter power. As long as transmitter power can be kept to within a few watts, they claim a distinct advantage can be gained through newly available solid-state S-band power sources such as varactor harmonic generators. These devices are said to offer weight, reliability, and life-time advantages over other thermionic sources.

In discussing the major roadblocks to use of millimeter and optical devices, the paper concludes that millimeter systems are presently hampered most by lack of efficient and reliable transmitter power sources, and that optical links for satellite communication applications will suffer from serious quantum noise limitations in addition to the problems posed by high power requirements, lack of efficient CW sources, and pointing accuracy problems. ⌗



Circle No. 7 on Subscriber Service Card

# Hydraulic System May Aid in Re-entry

***Republic lab tests at 1000° successful; radiation test results also look promising***

by Michael Getler

FARMINGDALE, N. Y.—Five years of Air Force-backed research in high-temperature hydraulic systems has yielded a prototype fly-by-wire primary control system able to operate under high pressures and extreme re-entry heat conditions.

The system, developed in the Fluid Systems Laboratory at Republic Aviation Corp., has also shown excellent operating characteristics under severe radiation conditions.

Republic has been working in high-temperature fluid research since 1952, with most of the earlier work centered on high-performance aircraft requirements. In recent years, supported by a string of contracts from Aeronautical Systems Division at Wright-Patterson AFB totaling about $2.3 million, the firm has moved into the operating temperature range likely to be encountered by manned space vehicles of the *X-20* or *Aerospace Plane* type.

In contrast to the 275-350°F fluid temperatures that must be withstood in current high-Mach number aircraft such as the F-105D or B-58, the 500°F anticipated for the RS-70, or 650°F for a supersonic transport, scientists here point out re-entry control systems must function in 1000°F fluid and 1200°F ambient environments.

Though re-entry control may not be a requirement for some time in the civilian manned space program, Republic scientists feel it will be essential for military space projects where pinpoint landing capabilities are required.

The Republic effort, in addition to hydraulic fluid studies, recently has extended to development of component hardware.

A complete system, built and tested here and also tested at a West Coast nuclear reactor facility, has been shown capable of operating for extended periods at fluid temperatures of 1000°F and ambient temperatures of 1200°F, under operating pressures of 4000 psi, and under extended 3-mw radiation dosages (the radiation tests were made at somewhat lower temperatures).

• **Fluid choice**—In selecting fluids, judged to be the most critical portion of the development program, Republic settled on mixed polyphenyl ether after studies that also included investigations of mineral oils, the esters, silanes, silicones, silphenylenes, and liquid metals.

William Mayhew, fluid systems lab supervisor here, points out that though some liquid metals can withstand higher temperatures than organic polyphenyl ether, the liquid metals are very difficult to handle with current technology and present a severe contamination problem because of alloy corrosion of components.

For extended operation at temperatures beyond re-entry extremes, Mayhew says liquid metals, with their high thermal stability and compressibility are the only possibility. However, a complete development program is required, including component hardware R&D.

Scientists here say it will be several years before the state-of-the-art in hydraulic system components will be advanced enough to allow compatibility with liquid metals.

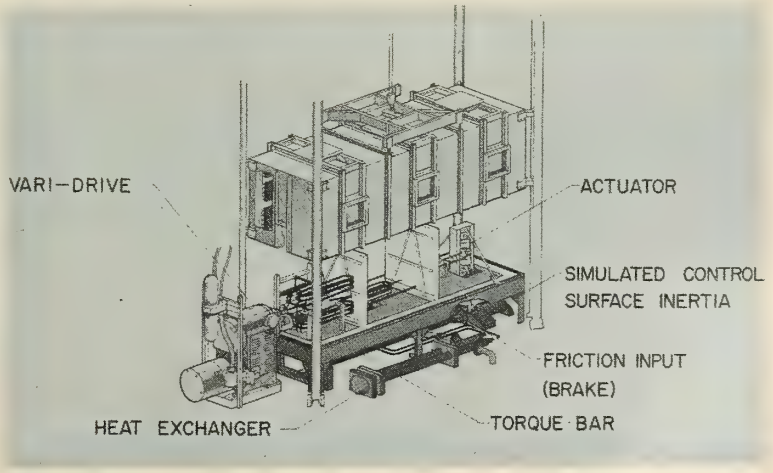
Republic recommends use of the polyphenyl ether for re-entry vehicle control systems operating at 1000°F fluid temperatures and 1200°F ambient for 1-5 hours. The ether, available at about $180 per gallon, is economical in comparison to some other compounds.

Furthermore, scientists note, ether has good lubrication qualities, is fire-resistant, non-corrosive, and displays excellent radiation resistance. While its decomposition point is lower than that of liquid metals, engineers were able to make the ether workable for a conservative 1-5 hr. period at 1000°F through advancements in system components.

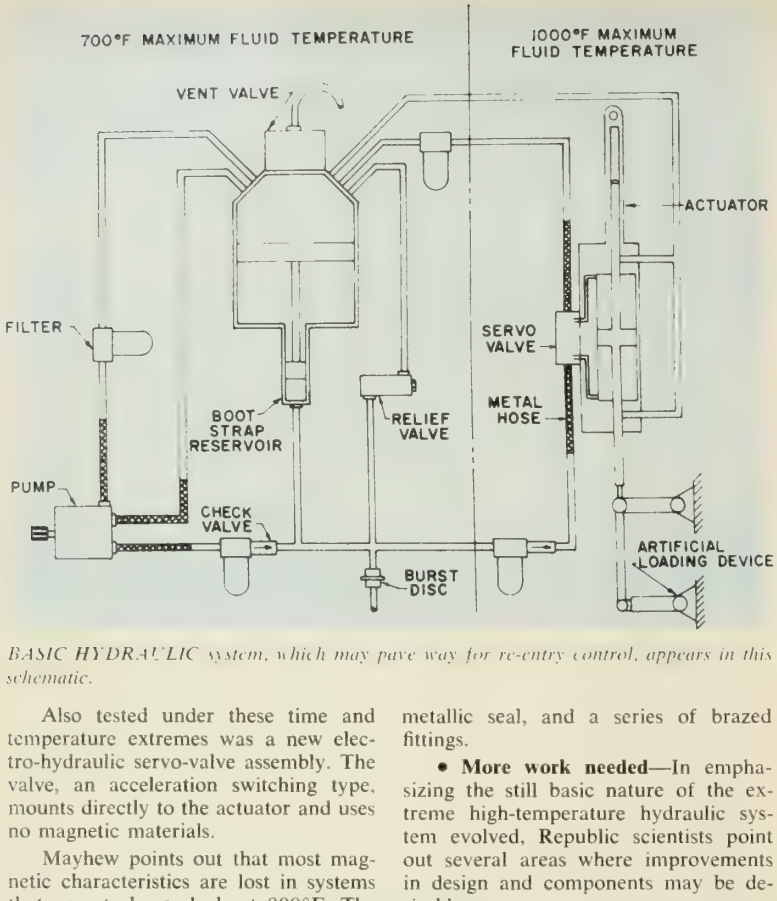
• **Component advances** — Though component development was considered less a problem than fluid selection, Republic, in conjunction with several subcontractors, reports several major new hardware advances for high-temperature systems.

Included in this category is a variable-delivery hydraulic fluid pump, developed by the Bendix Aerospace Div. at South Bend, Ind., capable at fluid inlet temperatures up to 700°F of flow rates up to 8 gpm at 4000 psi and operating at up to 8000 rpm. In 100-hr. qualification tests, 25 of which were at 700° and 75 at between 350-450°, no failures were recorded.

Successfully qualified under 1200° ambient and 1000° fluid temperatures in 100-hr. tests was a new flexible metallic hose developed by the Flexonics Div. of Calumet and Hecla, Inc., Maywood, Ill. The hose is used in system design to provide greater packaging flexibility than can be achieved with standard rigid coiled tubing.




*TEST SETUP for control system simulates temperatures likely to be encountered at various hydraulic system locations on space vehicle.*




*BASIC HYDRAULIC system, which may pave way for re-entry control, appears in this schematic.*

Also tested under these time and temperature extremes was a new electro-hydraulic servo-valve assembly. The valve, an acceleration switching type, mounts directly to the actuator and uses no magnetic materials.

Mayhew points out that most magnetic characteristics are lost in systems that operate beyond about 800°F. The present state-of-the-art for servo-valve operation, he reports, is about 400°F. The Bendix Research Laboratory and Bendix-Pacific combined on the servo-assembly development, with the Laboratory also turning out the servo torque motor.

To round out additional new component needs, Republic has evolved, from an in-house design,, a balanced, single-section (for test only), two-stage hydraulic actuator with a thrust at 4000 psi differential pressure of 27,-100 lbs.; also, a proprietary V-shaped metallic seal, and a series of brazed fittings.

• **More work needed**—In emphasizing the still basic nature of the extreme high-temperature hydraulic system evolved, Republic scientists point out several areas where improvements in design and components may be desirable.

These include: a method of fluid control that allows removal of some degraded fluid and replacement to increase endurance under high temperatures; development of pumps with fluid inlet temperature operating capabilities of at least 800°F, considered to be more realistic in terms of packaging requirements for an operational vehicle; investigation of rotary actuators to replace linear devices, also for packaging advantages; improved fluid reservoir design; and a host of component-improvement studies covering both manually and solenoid-actuated directional control valves, self-sealing couplings, shuttle valves, and thermal relief valves.

Republic engineers installed the unit in a three-chambered 180-kw oven to test the entire system. Oven temperatures were divided to simulate levels likely to be encountered in various hydraulic system locations on the vehicle.

The first chamber, representing the fuselage, was kept at 700°F for the maximum-temperature runs; the second chamber, simulating the wing section, heated the lines and fluid to 1000° (maximum 1300° ambient); and the third compartment, representing the wingtip of the vehicle and working actuator portion of the control system, was maintained at 1000° fluid and 1200° ambient.

• **Test results**—Recently completed endurance tests of the whole system operating under load (±20,000 lbs.) evaluated performance at 100° increments, beginning at 700°F fluid temperatures in the actuator section. Starting at this level already indicates a state-of-the-art advance, says Mayhew.

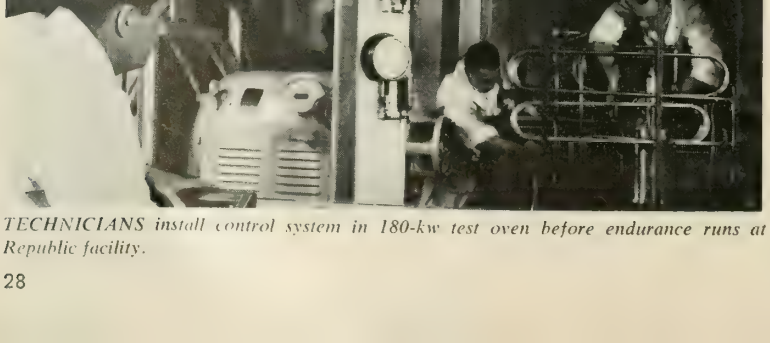
The system, according to Republic, showed trouble-free operation when tested at 700° for 50 hrs., 800° for 25 hrs., 900° for 10 hrs., and 1000° for 1.8 hrs. The 1000° test was actually run for 4 hrs., but the system was operating above 900° but below 1000° for 2.2 of the 4 hrs.

Mayhew reports system performance at some of these levels can be extrapolated far beyond those attained in first tests. The same fluid was used for all tests.

Preliminary analysis of radiation tests just completed at the Convair/Ft. Worth radiation facility on a small-scale unshielded version of the hydraulic system showed no serious hardware or fluid degradation after a 4-hr. 3-mw dose, with the system operating under load at 800° fluid temperature.

Mayhew, claiming that the system was not pushed to maximum in the initial runs, says it can withstand an even more severe environment. The 4-hr. dose, according to Republic, adds the equivalent of another 100°F to the system. Polymerization of the fluid, causing breakdown, is essentially the same from excessive radiation or temperature exposure.

Republic officials see major applications for systems of this type in both military and civilian manned spaceflight programs, with military usage likely to come first. Its current availability, they feel, could also make it a good bet for early testing with *Aerospace Plane*, if the project gets the go ahead. Other roles envisioned are in booster-engine gimballing, and for the fluid, as a heat exchanger for nuclear-propelled spacecraft. ⁂



*TECHNICIANS install control system in 180-kw test oven before endurance runs at Republic facility.*

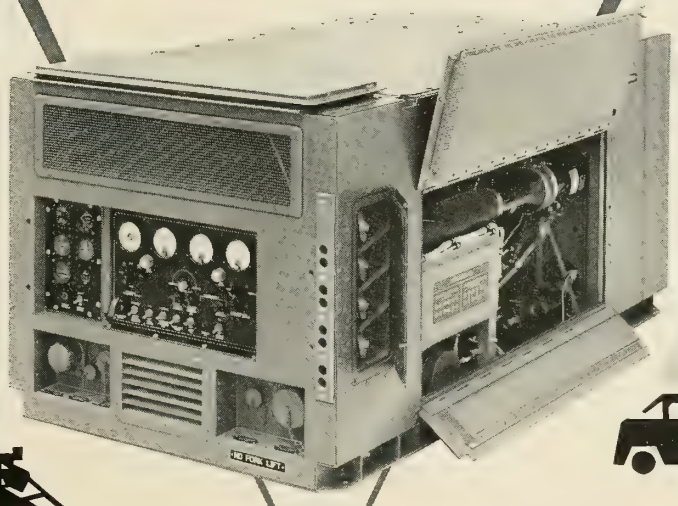
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# Cost Consciousness Yields Bullpup Engine Savings

**by John F. Judge**

BRISTOL, PA.—Cost-conscious management at the Reaction Motors Div. production plant of Thiokol Chemical Corp. saved about $1.2 million here in the first production run of the Navy's *Bullpup* prepackaged liquid engine (LR 58).

This cost comparison is based on original budget estimates, since the LR58 production run represented the first prepackaged liquid engine assembly line of its kind, but RMD spokesmen consider it valid. None of the items in the compilation resulted from the kind of savings normally associated with large-volume production.

Each saving was effected through specific and detailed investigations into every phase of the engine's production schedule. Some came from applying machining innovations, others through new metalworking capabilities not available at the time of the original estimate.

The RMD production plant has standard floor equipment, common to any major metal-fabricating manufacturer. Most of the savings appeared as changes in production flow, engine part design, or reduction in man-hours.

• **Broadly based**—Cost vigilance is a company policy, reaching the shop floor through an actively promulgated, two-way suggestion system. Any employee's idea may be considered by management. Management in turn follows through by answering each suggestion, detailing the reasons for acceptance or rejection.

The million-dollar-plus figure is the result of innumerable savings, some large and some relatively small. Cost-cutting steps during contract work included:

—Replacement of ⅛-in.-dia. rods with $^{3}/_{16}$-in. rods cut $181.71 from the original ceramic spray-coating operations on the chamber and nozzle of each engine. (All cost figures are based on a single engine.)

—Design of a simple center-head inspection fixture eliminated 11 hand-measuring operations rated at $3.15. A similar step in the adapter inspection area replaced 13 manual operations at $0.75 per engine.

—Redesign of oxidizer fill ports, dropping one drilling operation, saved $2.40.



*PREPACKAGED engines are loaded at the RMD production facility. Here fuel is metered into a Bullpup engine in one of the last production steps.*

—Design of another fixture which stepped up the X-ray inspection rate in center section checking, saving $1.50.

—Adoption of a Polaroid Land camera in recording propellant loading data trimmed $2.85 from each engine's cost.

—Redesigning the safety switch and resistor assembly to accommodate a single electrical harness simplified the component and saved $8.62.

—Changing to a one-piece stamping in fabricating the diffuser assembly, instead of the original three-part weldment, saved $21.24.

—A change in the operating sequence involving machining of sealing-ring grooves in the detail part rather than in the assembly cut off another $3.95.

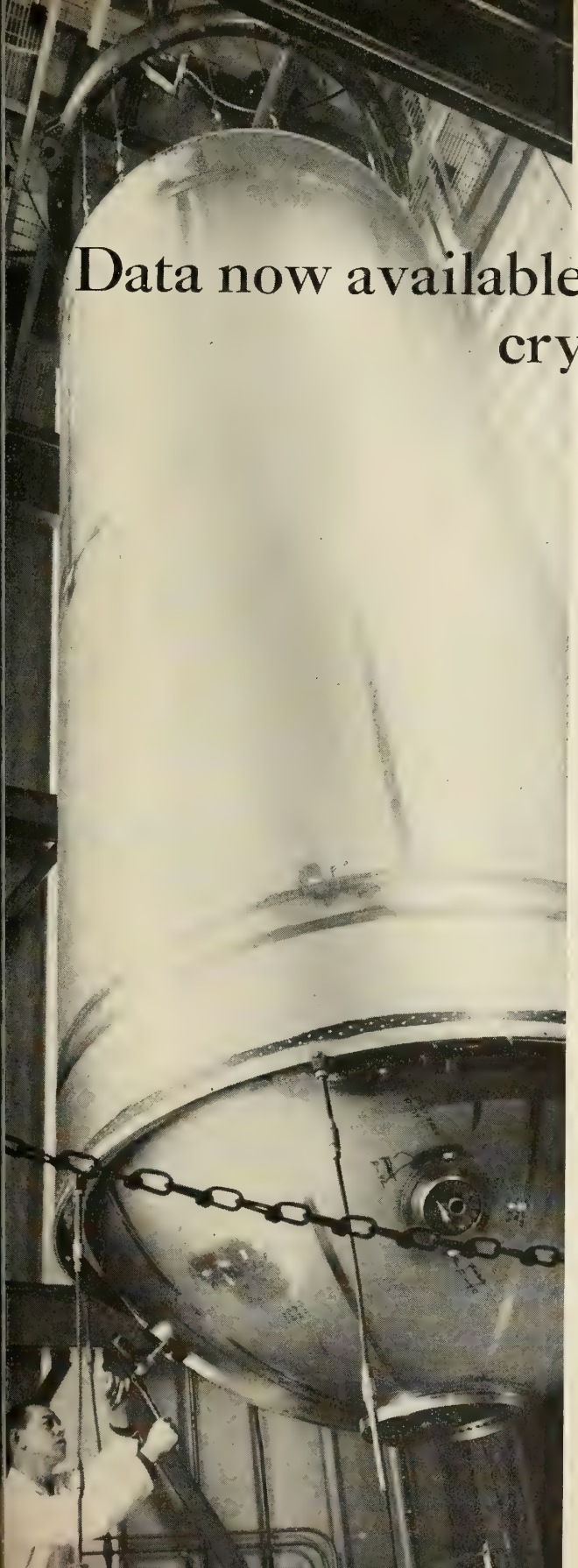
—Work measurement procedures resulting in production standards assuring equitable contributions from each employee shaved $63 per engine.

—A shift to decals instead of stenciling saved $1.46, and another $4.50 was realized by installing a deburring machine for center headers.

—Buying a fuel tank forging rough-machined cost Thiokol a nickel more per unit but cut LR58 labor costs by



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*7,000 gal. titanium tank for liquid hydrogen built by Beech Aircraft*

# Data now available on Titanium's cryogenic properties

Titanium can hold more liquid hydrogen at less tank weight than any other material and still give you impermeability to hydrogen, generous elongations and notch toughness at –423F.

**Some specifics.** The liquid hydrogen tank shown here was built and successfully hydrostatically tested by Beech Aircraft Corp. Capacity: 7,000 gallons. It was fabricated from sheet supplied by Titanium Metals Corporation of America to less than AISI tolerances, in thicknesses ranging from 0.014 to 0.025 inches.

**Cryogenic alloys.** The alloy used was Ti-6A1-4V ELI, one of two alloy grades advanced by TMCA specifically for liquid hydrogen service. The other grade is Ti-5A1-2.5Sn ELI. The designation ELI stands for Extra-Low Interstitials. Typical properties of these grades at –423F:

**Ti-6Al-4V ELI:** tensile strength, 263 ksi; yield strength, 248 ksi; notch tensile strength, 211 ksi; elongation, 7%.

**Ti-5Al-2.5Sn ELI:** tensile strength, 229 ksi; yield strength, 206 ksi; notched tensile strength, 233 ksi; elongation, 15%. Compare these properties with stainless and aluminum. You'll see why titanium guarantees more payload!

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*ONE EXAMPLE of process cost reduction involved a switch from an oxidizer tank and ring forging assembly to a one-piece oxidizer tank forging through a capability that didn't exist at the time the original cost estimate was made.*

$3.85. Purchase of the oxidizer as a rough-machined forging saved another $16.33 in labor and material costs.

The forging capability illustrated was not available at the time of the original engine cost estimates. But the single innovation also resulted in a number of hidden savings—evidenced by the man-hour and part movement reductions.

In another instance, Thiokol invested $17,400 in an automatic X-ray film developer that cut the cost of X-ray film processing alone by $4.35 per engine. The additional savings in personnel, processing rooms and time based on the plant's former equipment is not represented here.

The prepackaged engines are shipped from the RMD plant loaded and ready to fire. The unit is essentially two fuel chambers with a simple mixing valve connecting both with the combustion chamber. Start of the ignition sequence actuates the only moving part, which shears open several injection orifices, allowing fuel and oxidizer to mix in the combustion area. The mixture ignites on contact, burning with a smokeless flame.

The *Bullpup* is assembled by the Martin Co. Both the Navy and the Air Force have ordered the weapons. ⁂




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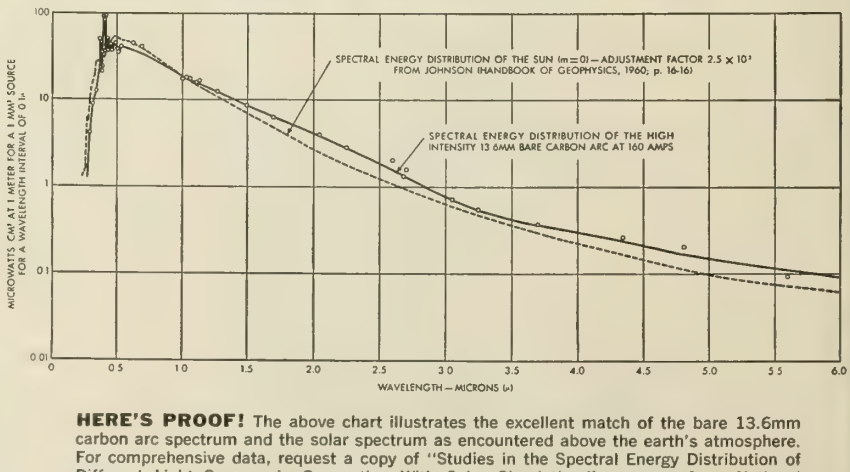
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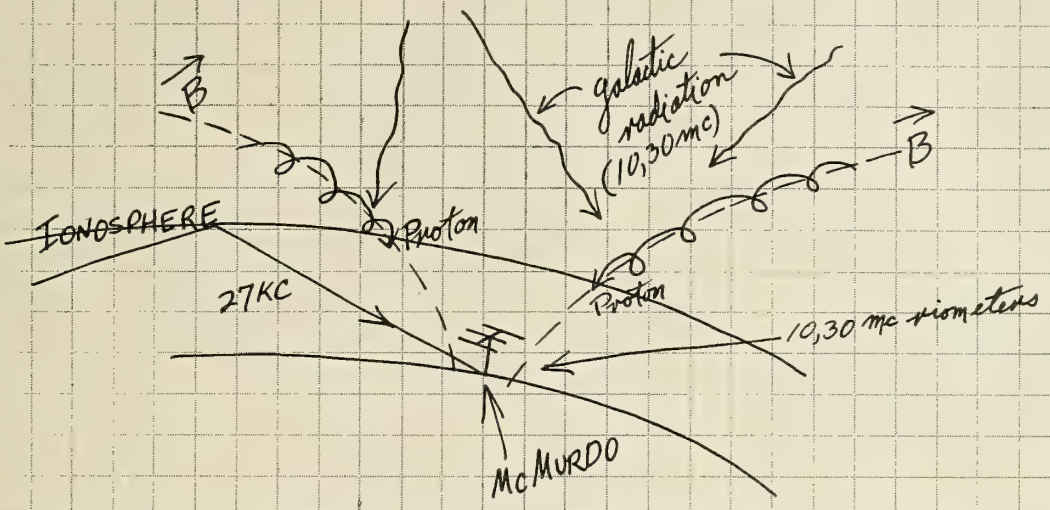
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*Of interest to engineers and scientists*




# ANTARCTIC RIOMETER PROGRAM

*...one of more than 500 R&D programs under way at Douglas*

This Douglas program is being conducted in cooperation with the National Science Foundation with these objectives:

To investigate the apparent existence of a world-wide semi-annual variation in the occurrence of polar cap absorption events; to determine the frequency and time-intensity of solar cosmic ray events; to correlate North and South Pole riometer measurements and study differences in the polar ionospheres; to study the effects of radiation on ionospheric parameters.

The program will continue through the next solar sunspot maximum in 1969. Among other aspects, it will be useful in setting up criteria for the protection of astronauts from radiation.

**Of career interest to engineers and scientists**

Douglas has entered into a period of greatly expanded activity in research programs like the one above and huge development projects like Skybolt, Saturn IV, Rebound, and others. Outstanding positions are now open in practically all scientific and engineering fields related to missile systems and space exploration.

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# A fuel cell for Apollo

This is a model of a fuel cell designed by Pratt & Whitney Aircraft—the company chosen to develop a fuel cell system for Apollo, America's first manned lunar craft. The Apollo spacecraft will be built for NASA by North American Aviation.

The hydrogen-oxygen cell will supply power for environmental conditioning, communication, instrumentation, and scientific equipment. In addition to generating electricity, the fuel cell will provide water for Apollo's three-man crew.

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DIVISION OF UNITED AIRCRAFT CORP.
EAST HARTFORD, CONN.

Pratt & Whitney Aircraft's fuel cell is far more efficient than conventional power systems. During tests, cells have demonstrated efficiencies of 70 to 80 per cent.

The fuel cell has a significant role in space. Moreover, it promises to be a significant power source on earth. Pratt & Whitney Aircraft is currently studying fuel cell power systems for such applications as remote-site power, vehicle propulsion, commercial power generation, and other industrial tasks.

*In major DOD speech . . .*

# Rubel Spells Out Space Philosophy

## *Official notes that space R&D effort is likely to top $1.5 billion in '63, hardware funds have been tripled*

*PERHAPS the most thorough statement to date on DOD's attitude toward the military in space is the speech (here somewhat condensed) recently delivered by Asst. Defense Secretary John H. Rubel at the Aerospace Luncheon Club in Washington. (See Editorial, p 46.)*

MY TALK TODAY is concerned with the space program supported by the Defense Department. This program is often spoken and thought of as the "military space program," particularly by its critics, who may use the adjective either to argue that it is too big or too small. I propose to demonstrate that the program is as close to the optimum size as we can make it in the light of all the uncertainties that must accompany such a program, and, in fact, that we probably err on the side of allowing too generous a margin of safety for the effects of these uncertainties.

Actually, of course, extensive programs and projects under NASA supervision will prove equally applicable to systems and devices in space whether these are used for military or non-military purposes. In this sense, then, the totality of our "military" space efforts, assessed from a national rather than a Departmental viewpoint greatly exceeds the efforts supported by the Defense Department alone.

I will make four principal points in this talk as follows:

First, in discussing the mission and objectives of the Defense Department I point out that this is not the Department of Space, but the Department responsible for national defense and that any undertakings that are supported by the Defense Department, whether or not they are space projects, must further that basic mission and those objectives.

Second, I discuss the requirements for space programs and projects. The principal point here is that our expenditures on space developments have been remarkably high in relation to viable concepts for military applications in space. In fact, despite extraordinary efforts we have not evolved any very new ideas for military applications in space during the past several years. This is especially true of manned military applications. Nevertheless, we have tripled our hardware efforts just in the last three years. I note that about half of our efforts are directed at clear, identifiable military needs but that half of them are not, and comprise a very extensive program of technological insurance against an uncertain future.

My third principal point, which concerns the scope of the DOD space program, is simply that it is a very large, not a very small, program.



**Assistant Secretary Rubel**

Fourth, I point out that decisions are not made about the scope of a space program as such. They are based principally on the value of particular ideas and program proposals.

Lastly, I note that space is a new frontier, although certainly not the only new frontier in the world today, and that we in the Defense Department are determined to be out on that frontier.

• **Mission and objectives of the Defense Department**—Basically the Department of Defense is charged with military preparations essential for the protection of our vital interests. To do that effectively and well is a foremost objective. Our efforts with respect to space undertakings supported by the Defense Department are, therefore, aimed at enhancing as necessary our military power and effectiveness. There are, of course, a multitude of fascinating and potentially useful projects that one might undertake in this new field, but unless we can satisfy ourselves that these efforts contribute to our military mission, or are likely to, we are not justified in supporting them. This is not the only criterion, but it is a minimum criterion.

• **Military requirements in space**—The first step in determining what our program ought to be is to identify military needs and requirements so that plans may be set to meet them. Space developments, of course, are close to the forefront of modern technological advances. We must plan not only on the basis of our present knowledge, but knowing that discoveries that suggest new applications might occur in a wholly unplanned and unplannable way.

This process is not a new one. We have devoted great efforts over a long period of time to studies of space in general and to military applications of space systems in particular. The Air Force assigned a series of space studies to the Rand Corporation as early as 1946. These were followed by a dozen more completed and assessed in 1947, and those were the basis for many more. The "study requirement" program, started in 1956, sponsored numerous industry studies. Some of these were paid for by the Government, but many were performed "gratis" by interested contractors who were granted a "need-to-know." This study program concentrated heavily on space missions and applications. The Air Force established additional permanent study groups and activities including the Anser Corporation in 1958 and more recently, the Aerospace Corporation which performs such studies as well as other tasks. Numerous ad hoc efforts have been undertaken in recent years by in-house and consulting bodies, including some sponsored by the Air Force Scientific Advisory Board and others by the Navy Department. No listing here could be more than a partial one. Many tens of millions of dollars have been spent —representing many thousands of man-years of effort—either directly or indirectly in studying military applications for space in the past five years, exclusive of normal preliminary design efforts needed in pursuit of authorized projects.

One of the most interesting aspects of this effort is that no really new ideas for the military utilization of space have been evolved as a result of these efforts. New techniques have been evolved or postulated, of course but the list of system proposals under active consideration shortly after *Sputnik I* is remarkably similar to today's list. Many of these are being heavily supported, but others are not. This does not prove, of course, that new ideas will not be forthcoming. It does not prove that all the decisions to proceed or not to proceed have been correct. Nor does it prove that we have studied the problem sufficiently; we are still studying. But it does suggest that our development efforts are not lagging behind the good ideas. In fact, during the past three years we have increased the scope of our hardware development efforts by a factor of more than three. These efforts may be classed under two principal headings.

• **Projects aimed at military require-**

**ments**—First are those projects which are directed at clear, identifiable military needs and requirements. About half of our total effort falls under this heading. We have been working on many of these for sometime and most still appear promising today. Examples include the development of communications satellite systems. We have already spent nearly $200 million on such developments and we are planning to spend $100 million in this fiscal year. We are continuing to support the development of navigational satellites. We have already spent nearly $100 million on this and we will spend nearly $50 million in this fiscal year. Despite great technical difficulties and disappointments, we continue to support the development of a satellite system for ballistic missile warning. We have already spent nearly $300 million on that development and we will spend up to $100 million more in this fiscal year.

These and a few others are examples of promising applications of space technology for military purposes. The decision to pursue such projects, to expand them, to cut them back or otherwise to modify them as problems arise are made precisely as decisions must be made with respect to any other complex system under development to meet military needs.

• **Evolution of essential "building blocks"**—Though about half our efforts in space are undertaken to meet well-defined military needs and requirements, the other half are not. This other half comprises the second major class of efforts we are supporting in this field, and it is a very important one. The first is aimed at developing systems to meet needs; the second is aimed at evolving new opportunities, at creating a vigorous and broad base of new technology and even of devices and systems for possible future application, even though the requirements for these are incomplete or altogether absent.

An important example is *Titan III*, the development of which was recently approved. We plan to expend more than $250 million in this fiscal year and a total of nearly $1 billion in developing *Titan III* as a part of the National Launch Vehicle Program. It will be a standardized workhorse launch vehicle useful for the better part of a decade. *Titan III*, however, is not being developed to fill a specific military mission requirement that adequately justified its development. No such requirement presently exists. We are supporting its development nevertheless because we are confident that it will be an important "building block" upon which future military space missions and operations, should they materialize, will be heavily dependent.

*Titan III* is not the only major "building block" currently being supported by the DOD, although it is by far the largest system development in this category. We are also supporting exploratory and advanced developments aimed specifically at the evolution of "technological building blocks" for space to the extent of more than $300 million in Fiscal Year 1963. These developments include a great variety of efforts in bioastronautics, the development of advanced sensors, the evolution of advanced propulsion systems and power supplies, developments in materials, and a multitude of exploration and research efforts aimed at learning more about space flight and the space environment.

These "building block" programs and projects are conceived and supported on a broad base complementing NASA efforts to insure the availability of space technology for application to new military systems as their characteristics and the need for them are clearly established.

Many of the applications that have been contemplated seem to us today to be unlikely, if not infeasible. Most manned miiltary missions in space still, after years of study, seem little or no more viable than they ever did. The same may be said of many unmanned systems, especially systems employing offensive weapons in space. Nevertheless, we are anxious to build a base on which future systems could, if needed, be constructed. We are not yet ready to design the building, but we want the building blocks at hand.

• **Scope of DOD space program**—Now let's put together the two parts of our space program—the "application" and the "insurance" parts—and examine the scope of the total effort.

Until recently research and development played a comparatively minor role in the evolution of our military posture and in the operations of the Department of Defense. In fact, the budgetry category known as Research, Development, Test and Evaluation was not established until Fiscal Year 1960. Today our total RDT&E program amounts to $7.1 billion (FY 1963). It equals nearly half of the expenditures for the procurement of all weapons systems and supporting systems for use in combat and support of combat operations. Stated somewhat differently, for every dollar that we spend to furnish a weapon for the fighting man to use we spend nearly fifty cents to develop a new one or to improve an existing one. The impact of this historically unprecedented effort on the character of our military weapons and the development of new military capabilities, is, of course, one of the dramatic facts of life in the modern world.

Between 20% and 25% of this effort is currently devoted to our military space program. We know that because we have made extensive and special studies of our total research and engineering effort and have identified space program and projects separately. It is the aggregate of these that comprise what I have been referring to as the Department of Defense "space program."

This program exceeds $1.5 billion this year and is likely to be even larger next year.

It is greater than the entire Army budget for RDT&E.

It is greater than the entire Navy budget for RDT&E.

It is not a small effort, but a very large effort. As I have already mentioned, at least half of this effort is devoted to the evolution of new technologies and devices not aimed at implementing clear military requirements. It is very large in relation to the funds and the efforts we are expending in research and development aimed at the creation or improvement of new systems and new capabilities of demonstrable military value and effectiveness. It competes with these, and as it grows, becomes a correspondingly larger and more important factor in decisions affecting total Defense research and development.

• **Policies and decision-making — I** would like to turn now to the policies that govern decisions affecting the size and scope of our Defense space program. Basically, decisions on any segment of our research and engineering program are governed by four principal considerations:

First, systems for operational use, or developed as candidates for deployment, must meet clear cut military requirements.

Second, although the establishment of requirements is bound to be affected by technical opportunities and change, requirements for military equipment must be fully consistent with the basic objectives of the Defense Department as I outlined them earlier. In other words, decisions must be governed by what we ought to do, not just what we can do, although new developments often affect both.

Third, developments must be feasible and worth the expenditure of funds and effort in relation to urgency and effectiveness. Those of us with responsibilities in the field of research and engineering are particularly concerned with the effective utilization of our precious scientific and engineering manpower resources, for the bulk of the funds for research and development measure and determine the areas toward which their efforts and talents will be directed.

And, finally, we are governed in our R&D decisions by the need to insure continued technological growth in all fields of military interest and concern, especially in advanced fields requiring heavy support by the DOD.

Needless to say, technical and policy decisions concerning the development of systems for military use are not made on general or philosophical grounds. We do not simply decide to spend more or to spend less on a system or a group of systems. Each major decision is and must be made on its merits in the context of the objectives we are trying to attain.

Needless to say, too, system decisions are not made in response to or in furtherance of abstract doctrinal concepts. *Polaris* does not augment America's "sea power" in the Mahan sense, nor was it started and supported because anyone thought it would. *Minuteman* does not augment America's "air power" in the conventional sense any more or any less than *Polaris* does, nor is it either supported or opposed because it is essentially a "land" system, owing its survival to dispersal and hardening under ground. Doctrinal abstractions such as "sea power" or "air power" or "aerospace power" are often useful for analysis and discussion of the patterns of power as history reveals them. But these doctrinal abstractions do not translate well into new programs and projects. Here technology takes over, and technology, as we have noted, tends to obsolete such concepts and abstractions rather than the reverse. ⁂

## Westinghouse, Boeing Reorganize

In a move toward greater emphasis on defense and space projects, Westinghouse Electric Corp. has consolidated all its defense and space-oriented nuclear and electronic resources in a new Atomic, Defense & Space Group. Formerly called Defense & Space Group, the new operation now includes Westinghouse Electric's Astronuclear Laboratory at Large, Pa.; Cheswick, Pa., Atomic Fuel and Atomic Equipment Divs.; Plant Apparatus Div., Pittsburgh; and Bettis Atomic Power Laboratory near Pittsburgh, operated by the company for AEC.

Also included in ADSG are the Aerospace Electrical Div. and the Baltimore Defense Center, including BDC's Electronics, Air Arm, Ordnance, Systems Management and Astroelectronics functions. Charles H. Weaver, vice president and former head of the firm's Atomic Power Group, is now head of ADSG, which reports to John K. Hodnette, executive vice president. Other appointments in connection with the reorganization are:

Gen. Albert Boyd, VP and former general manager of the Defense and Space Group, now VP in charge of ADSG planning operations; Dr. John A. Hutcheson, former VP for engineering and research, now VP in charge of ADSG technical operations; John W. Simpson, VP and former general manager of the Atomic Power Divisions, successor to Dr. Hutcheson as VP for engineering research. . . . *Boeing Co. has reorganized the engineering and product development of its Aerospace Div. along program lines. Now each of its major programs—Minuteman, Saturn, X-20 and Bomarc—is considered a distinct branch, with each program manager reporting directly to the division's general manager, Lyle Wood. Boeing's largest division, Aerospace has more than 50,000 employees.*

## 'Lean Years' Coming for GD/A?

General Dynamics/Astronautics has started on a "downhill slide" with windup near for its billion-dollar-plus *Atlas* program—despite a two-year campaign to avoid the slacking off that seems bound to come.

"It is our turn to go hungry," division president J. R. Dempsey said. "It is clear that we are not going to get any programs like *Atlas.*"

Dempsey concedes that few large programs are coming up now, but he places much of the blame on the fact that in the past two years "we were unable to convince anybody that we had the capability to take on new major projects. With Astronautics building up to peak employment of 30,000 (reached last April) on *Atlas,* potential customers regarded it as 'too fat,' when as a practical matter we knew we would start downhill unless we got new business."

The division consequently won no competitions, Dempsey said, though "we bid on *S-4,* we bid on *Apollo,* we bid on *S-1B, S-2* and *RIFT.* On every one of them we think we were either first, second, or third in technical evaluation."

The division's new $78-million *Atlas* standardized launch vehicle contract will not slow its continuing work force reduction. Unless major new business is found, employment is expected to drop from the present 26,200 to 21,000 by the end of this year. By late 1963 it may reach 15,000 —several thousand less than the division wants to maintain.

Current business consists of 99 active contracts; *Atlas* is covered by 30 of these, some of which will produce continued sales in spares, training missiles, test firings and product improvement.

To help generate new business and prepare GD/A to become more than a "one-product company," as Dempsey puts it, funds have been boosted in order to nearly double GD/A's R&D activity, to increase the proposal and bidding budget and to expand general engineering for development growth.

## New Firms & Divisions Formed

A newly formed team of consulting specialists in technical and marketing problems has been formed under the name of Michael D. Altfillisch & Associates. The firm offers diversified services by graduate engineers and scientists with experience in product planning, R&D, marketing, management, and other fields. Specialties of various members of the new firm include: electronic and process instruments, nuclear instrumentation, photoinstrumentation and high-speed photography. . . . *Fabritron, Inc., is a new Buffalo, N. Y. fabricator and assembler of industrial laminates, thermoplastics, fibers and specialized metals. Russell A. Reynolds is president of the new company.* . . . Whirlpool Corp. has set up a systems div. to handle the company's work in development of life-support systems and other research projects for various government agencies. . . . *Southwest Center for Advance Studies has formed its first operating unit—Upper Atmosphere and Space Sciences Div.—headed by Dr. Francis S. Johnson, former manager of space physics research at Lockheed. SCAS has a campus site at Richardson, Tex.*

## Packard Bell & Marquardt May Merge

Marquardt Corp. and Packard Bell Electronics Corp. are studying the possibility of a merger. President Roy E. Marquardt indicated that, while a "very serious joint study" is under way, the matter is still in the "investigative" stage—therefore, no formal notice of intent to negotiate has been filed with state officials as required by law.

Marquardt's objective in such a merger would be expansion of its defense electronics capabilities. Packard Bell, reportedly having troubles recently, has sales of about $50 million annually, with roughly half of the figure for defense business.



## Chemical, Mechanical, Aeronautical, Electronic Engineers/Chemists/Physicists/Mathematicians

At ALLEGANY BALLISTICS LABORATORY, operated by Hercules Powder Company for the Navy since 1945, wide ranging R & D programs are aimed at advancing the state of the art in all phases of rocketry, to meet the need for hotter propellants and a new order of precision in guidance and control. □ This is a stimulating, interdisciplinary effort. The scientist and Engineer at ABL works in close collaboration with specialists in many other fields, in an invigorating atmosphere of success. Past achievements include: Deacon, Talos, Terrier, Nike rockets and boosters; last stage motors for Polaris A-2 and A-3; the ALTAIR motor, which has furnished critical upper stage propulsion for over 50 successful launchings of satellites, space probes and test vehicles. □ Previous rocket experience is not essential for many of these positions. Demonstrated capability in your discipline is the prime criterion for an assignment in one of the areas below.



# QUEST for a new order of THRUST & CONTROL



**ADVANCED DESIGN RESEARCH (BS, MS, PhD).** Studies for advanced rocket systems to establish system concepts and optimize preliminary design criteria.

**MECHANICAL DESIGN RESEARCH (BS, MS, PhD).** Of materials behavior, exhaust gas control, insulation. Hardware feasibility studies for future systems.

**DESIGN AND DEVELOPMENT (BS, MS).** Of complete rocket motors, including pressure vessels, nozzles, all accessories. Experience in fluid flow, stress analysis, heat transfer, and mechanics desirable.

**COMBUSTION RESEARCH (MS, PhD).** Theoretical and applied studies of combustion process in rocket chamber under firing conditions.

**GAS DYNAMICS (MS, PhD).** Analytical and experimental studies of particle flow, nozzle efficiency, altitude performance parameters, thrust magnitude and vector control.

**PROPELLANT RESEARCH (MS, PhD).** Theoretical and experimental investigations of propellant detonability, bonding characteristics, propellant formulation, morphology and rheology of filled solid polymers and slurries, stress analysis.

**STRESS ANALYSIS (BS, MS, PhD).** Analysis of filament-wound pressure vessels and rocket motor components.

**ENGINEERING SPECIALISTS (BS, MS, PhD).** 8-10 years experience; analysis, heat transfer, systems analysis, missile ballistics, internal rocket ballistics, insulation, fluid dynamics.

**INSTRUMENTATION (BS, MS).** Design and develop instrumentation to obtain data from static firing tests, entire cycle from sensing devices on motor to data collecting mechanisms. Design and develop process instrumentation for production of propellants and component chemicals.

**PROCESS ENGINEERING (BS, MS).** Design improved material handling, molding, tooling and process equipment for propellant and rocket manufacturing.

**TEST ENGINEERING (BS, MS).** Build and analyze static firing test stands and associated hardware. Recommend range handling and operating equipment including environmental test.

**ACOUSTICAL PHYSICS (MS, PhD).** Analyze behavior of burning rockets under various acoustical phenomena.

**DATA REDUCTION (BS, MS).** Prepare calculation systems for programming complex data into IBM 7074 computer.

**STATISTICS (MS, PhD).** Apply statistical methods to quality control, reliability, research test procedures and analyses of test data.

Write in confidence to: Mr. W. D. Linkenhoker, Dept. 3K-4

**Allegany Ballistics Laboratory**
**OPERATED BY HERCULES POWDER COMPANY**
**FOR BUREAU OF NAVAL WEAPONS**
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# contracts and procurements

## AWARDS

### AIR FORCE

$39,566,000—**Avco Corp.'s Lycoming Div.,** Stratford, Conn., for production of a new generation of re-entry vehicles.

$25,411,000—**Space Technology Laboratories, Inc.,** Redondo Beach, Calif., for systems engineering and technical direction in support of the *Atlas, Titan* and *Minuteman* weapon systems and the ballistic missiles re-entry systems program (supplemental contract). Work to be done at Norton, AFB, Calif.

$19,000,000—**Aerojet-General Corp.,** Azusa, Calif., for *Stage II Minuteman* solid-propellant rocket motors (2 supplemental contracts). Work to be done at Sacramento, Calif.

$13,900,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for *Skybolt* missiles and related equipment (supplemental contract).

$9,199,600—**Space Technology Laboratories, Inc.,** Redondo Beach, Calif., for site activation support for *Atlas, Titan* and *Minuteman* weapon systems. Work to be done at Norton AFB, Calif.

$3,291,288—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on a space program at Sunnyvale, Calif. (supplemental contract).

$2,559,717—**Halvorsen, Inc.** and **McLaughlin, Inc.,** Spokane, Wash., for erection of antenna support facilities for *Titan* missile bases.

$2,000,000—**General Telephone & Electronics Corp.,** Mountain View, Calif., for production of electronic security systems for the *Atlas* and *Titan* missile programs.

$1,318,247—**General Electric Co.,** New York City, for production of airborne guidance equipment and for conducting test operations in support of various missile and space programs.

$1,200,000—**Radio Corp. of America,** New York City, for work on the ballistic missile early warning system at Moorestown, N. J. (supplemental contract).

$1,006,000—**General Dynamics Corp.,** New York City, for development, design and engineering of communications systems for ICBM bases.

$500,000—**Bendix Corp.'s Eclipse-Pioneer Div.,** Teterboro, N. J., for development of a hot-gas servo control system designed to the requirement of the GAM-87A *Skybolt* missile.

$400,000—**Radiation, Inc.,** Melbourne, Fla., for design and production of a telemetry system using molecular electronic circuits.

**United Technology Corp.,** Sunnyvale, Calif., for preliminary work on 120-in. dia. segmented solid-propellant rocket motors for the booster stage of the *Titan III program* (undisclosed amount).

**Telecomputing Corp.'s Power Sources Div.,** Los Angeles, Calif., for space vehicle batteries (undisclosed amount).

### ARMY

$50,000,000—**Douglas Aircraft Co.'s Missile & Space Systems Div.,** Santa Monica, Calif., for continued research and development of the *Nike-Zeus* anti-missile missile.

$18,662,500—**Bendix Corp.'s Eclipse-Pioneer Div.,** Teterboro, N. J., for production of items for the *Pershing* missile system.

$6,117,887—**Bendix Corp.'s Eclipse-Pioneer Div.,** Teterboro, N.J., for engineering services on the *Pershing* missile system.

$1,188,161—**Radio Corp. of America's Defense Electronic Products Div.,** Moorestown, N.J., for missile test and tracking equipment.

$500,000—**Continental Electronics Manufacturing Co.,** Dallas, Tex., for construction and delivery of two VHF transmitters for Stanford Reseacrh Institute.

### NAVY

$15,000,000—**Sperry Gyroscope Co.'s Marine Div.,** Syosset, New York, for ship's inertial navigation subsystem equipment for fleet ballistic missile submarines and naval shore and training installations.

$10,840,816—**Vitro Corp. of America's Vitro Laboratories Div.,** Silver Spring, Md., for engineering services on the *Polaris* weapon system.

$116,687—**General Precision, Inc.'s Librascope Div.,** Tarrytown, N.Y., for servo module assemblies for the Naval Avionics Facility at Indianapolis, Ind.

### AEC

$5,000,000—**Burns & Roe, Inc.,** New York City, for design and installation of structural and operational systems for a special nuclear reactor facility.

### NASA

$636,052—**Land-Air, Inc.,** Chicago, Ill., for operation and maintenance of automated satellite telemetry data-processing equipment at Goddard Space Flight Center, Md.

$148,750—**Microdot, Inc.,** South Pasadena, Calif., for 90 channel temperature measuring systems for use in research and development of the three-man *Apollo* spacecraft.

### INDUSTRY

$1,700,000—**Diebold, Inc.,** Canton, Ohio, from **Boeing Co.,** for building security devices for use in the *Minuteman* missile launching sites.

$750,000—**Lear Siegler, Inc.,** Santa Monica, Calif. from the **Curtiss-Wright Corp.,** for production of rocket case sections for *Stage I Minuteman* missile. Work to be done by Astro Structures Div., El Segundo.

$130,000—**Perkins Electronics Corp.,** El Segundo, Calif., from **Martin Co.,** for missile ground support equipment-type DC power supplies.

$115,000—**Sylvania Electric Products, Inc.'s Microwave Device Div.,** Mountain View, Calif., from **Sanders Associates, Inc.,** for development of a new storage tube for a classified application.

**Clevite Corp.'s Mechanical Research Div.,** Cleveland, Ohio, from **Pratt & Whitney Aircraft Div. of United Aircraft Corp.,** for production of metallic fuel cell assemblies for the *Apollo* program (undisclosed amount).

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

Purchase Department, Bldg. 311-4
Naval Supply Center
Oakland, Calif.

Negotiate a contract with Western Gear Works, Everett, Wash., for delivery of a prototype hydraulic power drive for use in conjunction with shipboard missile transfer systems. This notice is for information purposes only as the work involves modification of equipment previously manufactured by this firm. RFP-228-4293-63.

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Aeronautical Systems Div.
Wright-Patterson Air Force Base, Ohio

Negotiations will be conducted with Minneapolis-Honeywell Regulator Co., Minneapolis 40, Minn., for additional study on the application of modern optimization theory to the problem of re-entry control system. Design and mechanization. RFP-ASD-161161-RKNB. Note: For information only, no RFP available.

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Directorate of Procurement/FTKL-2
Air Force Flight Test Center
Edwards Air Force Base, Calif.
Attn: G. M. Plock

Negotiations will be conducted with Thiokol Chemical Corp. for solid propellant formulations for testing under the ballistic test and evaluation system. For information purposes only.

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Aeronautical Systems Div.
Wright Patterson Air Force Base, Ohio

Negotiations will be conducted with Garrett Corp.'s AiResearch Manufacturing Co. of Arizona, Phoenix, for compatibility testing relative to Air Force type STU-15/A34 and Air Force type STU-17/A34 starter in support of the F-105 aircraft and the *GAM-77A* missile. RFP-ASD-6945-WMMM. Note: For information only, RFP not available.

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Hercules Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

The Army Material Command proposes to procure from Western Electric Co. 1900 man-days of engineering and technical services in support of the *Nike-Hercules* system. All inquiries relative to this procurement for subcontracting possibilities should be directed to Western Electric Co., 222 Broadway, New York 5, N.Y.

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Contracting Officer
Purchasing Dept.
Naval Supply Center
Norfolk, Va.

Special type missile hold-down strap assemblies, stainless steel contruction, in various sizes for installation aboard naval vessel—1048 each. Negotiation restricted to Marman Div., Aeroquip Corp., Los Angeles, Calif., and Davis Aircraft Products Co. which firms alone have demonstrated capability to furnish equipment suitable for the intended use. Delivery requirements will not permit delay incident to design development and manufacture by others. Suggest small business firms and others interested in subcontracting opportunities make direct contact with above firms. Firms interested in future procurements of this special type of missile hold-down assembly man contact the Chief, Bureau of Ships, Washington, D.C., for information. For information only, RFP not available.

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Operations Support Div.
Contractor Services Branch
Norton AFB, Calif.

Replenishment of spare parts in support of SMYC 2845-NC0583-8RGA (1/N 282733) body, thrust chamber—7 each. Delivery schedule 5-31-63. Item identified by P/N and description only. Specs, data and drawings not available. Notice is given that these items must be obtained from the prime manufacturer in order to secure safe, dependable and effective operations of the *SM65* weapon system. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with North American Aviation, Inc., Rocketdyne Div., 6633 Canoga Ave., Canoga Park, Calif.

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CO USA Ordnance District, New York
770 Broadway
New York 3, New York

Pershing missile rotary inverters, No. 10596906. Bendix Corp., Red Bank Div., Eatontown, N.J., has been selected for this procurement without competition. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.

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U.S. Army Engineer District, Detroit
Corps of Engineers
150 Michigan Ave.
Detroit 26, Mich

Construction of electronic parts, storage facilities and *Hercules* improvements, sites D-26 and D-612, in the vicinity of Detroit, Mich. Job—IFB EMG-20-064-63-5. Bid opening 10-26-62. Drawings and specs priced at $5.50 per set for full scale and $1.10 per set for half scale, nonrefundable.

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Bureau of Naval Weapons
Washington 25, D.C.

For information purposes only. The Bureau of Naval Weapons contemplates award of a contract to Westinghouse Electric Corp., Sunnyvale, Calif., for field engineering services in support of *Polaris* launcher system. Award will be made on the basis of a continuation of services previously started by this firm. This notice is made for information purposes only. Other proposals cannot be considered for the above procurement. PR No. SP-1076-63-1. BuWeps Synopsis No. 92-63.



# R/M ASBESTOS-PHENOLICS

**The component: MOTOR LININGS**

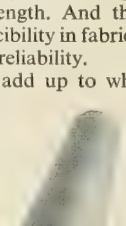
**The missile: TERRIER**

The Terrier shipboard missile literally puts missile firepower on instant readiness. This calls for lightweight materials . . . reliability . . . and prolonged storage in many types of climates without affecting performance.

R/M asbestos-phenolics are the accepted material for motor linings on the Terrier. They are virtually unaffected by environment and are compatible with solid fuels under a wide range of storage, shipboard and in-flight conditions.

They provide excellent thermal insulation and dimensional stability. They ablate uniformly. They save weight without sacrificing strength. And they show excellent reproducibility in fabrication as well as proved reliability.

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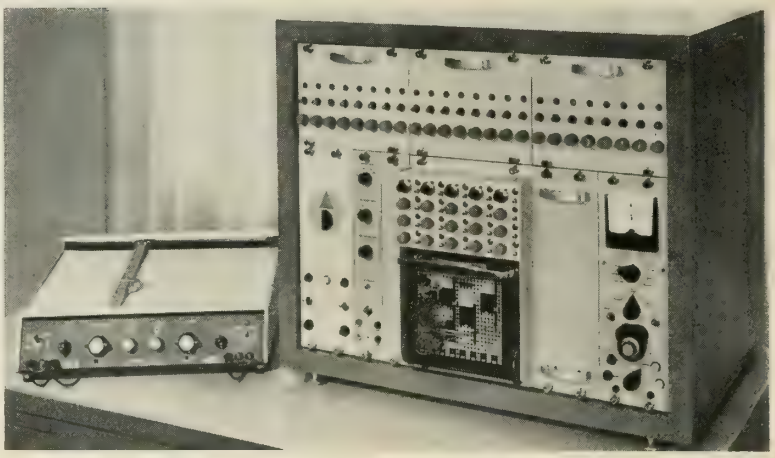
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## *New Product of the Week:*

## *Portable Analog Computer*

A compact analog computer is being marketed by Applied Dynamics, Inc. High-speed repetitive operation can be introduced by a switch that permits selection of compute periods ranging from 1.000 to 0.025 second. Time markers for Z-axis modulation of a readout oscilloscope are generated by the high-speed repetitive-operation control unit.

Accuracies of 0.200% per amplifier and 0.035% per multiplier can be obtained using high-performance components. Null potentiometer scales of 0 to 100 and 0 to 10 permit operator to set coefficients below 0.100 with 10 times normally obtainable accuracy.

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### Diode Tester

A diode tester that provides direct connection to all standard oscilloscopes for display of E-I curves for Zener, computer, power and tunnel diodes is being marketed by the Electronics Div., Disc Instruments, Inc.

Forward current and reverse voltage on the tester is continuously variable through five ranges. Push-button control allows rapid forward and reverse testing. Reverse leakage and forward current are controlled to prevent overloading by use of limiting circuitry. Automatic protection is provided to remove high voltage while changing diodes.

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### Electron Microscope

Norelco EM-75C electron microscope for teaching and general service applications has been developed by Philips Electronic Instruments.

The unit features variable electron acceleration up to 75 KV and independent lens controls that permit electron diffraction studies and electron imaging below 20 KV with good resolution.

Objective lens has an externally adjustable mechanical compensator with a single control, indexed and coupled to double dipoles positioned on the face of the pole shoe.

The instrument permits stereo images to be produced by rotating the specimin rod through a preset angle. Magnification is continuously variable from 1200-12,000 diameters on viewing screen.

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### Flawless Metal Mirrors

Fabrite Metals Corp. has developed spring-hardened brass mirrors which are produced in all sizes, gauges and mirrored on either one or two sides. Some of these are aloft on satellite vehicles, or with tracking equipment tracing the courses of such missiles. These metal mirrors are used wherever mirror reflectivity is required without the use of glass.

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### Portable Oscilloscope

A portable lightweight oscilloscope is available from Lavoie Laboratories, Inc. The Model LA-285 weighs 45 lbs. and provides a vertical frequency re-

sponse of DC to 30 MC. Dual time bases offer a choice of sweep times between 0.02 microseconds/cm and 12 seconds/cm in 18 calibrated sweep delay ranges from 1 sec to 10 sec. For calibration, portions of the sweep may be magnified and intensified.

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## Portable Communicator

A transistorized portable intercommunications amplifier is available from Cambridge Electronics for applications where voice exchange is vital in noise environments.

Model CE-1300 can also be used in construction, public utilities operations, fire service, conservation, pipe line installation, highway maintenance and construction, radio and television service, military and missile industries. It operates from an integral battery.

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## Residual Gas Analyzer

A residual gas analyzer capable of detecting minute quantities of gas remaining in evacuated systems is being marketed by Consolidated Electrodynamic Corp., a subsidiary of Bell & Howell.

Essentially a mass spectrometer without a vacuum system, the Type 21-613RGA is capable of detecting gases with partial pressures as low as 5 x $10^{-11}$mm Hg. It can be used to monitor gases within its mass range in any system operating at pressures less than $10^{-4}$mm Hg. Mass range of the instrument is m/e 2-4 and 12-150, with unit resolution over the entire range. A cycloidal focusing analyzer is used for the mass range of 12-150 and an auxiliary 180° collector for masses 2-4.

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## Subcarrier Oscillator

Dorsett Electronics has developed a transistorized voltage controlled subcarrier oscillator for telemetering applications. The Model 0-18D combines electrical and environmental stability specifications with the ability to accept data inputs of 0 to 5 volts or ±2.5 volts by a simple screwdriver adjustment of the external centering control. Linearity is ±0.125% DBW (design bandwidth) from best straight line. Amplitude modulation is less than 0.5 db across the band and harmonic distortion less than 0.5%.



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## Servo Repeater

Weston Instruments Div., Daystrom, Inc. offers a lightweight Model 1173 servo repeater which meets MIL-Spec environmental requirements and offers a slew rate of 60° per second, minimum. Designed primarily for aerospace applications, the repeater is adaptable to many industrial units. The unit accepts a 3-wire, Y-connected, 3-plate input signal and positions an output synchro via a servo system. Input and output characteristics may be altered to suit requirements. Standard operating power is 115 v, 400 cycles, but a 26-v, 400-cycle unit is optionally available. The unit is designed to operate through a temperature range of −65°F to 160°F, and at 100% humidity. Operating life is a minimum of 1000 hours.

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## Versatile Galvanometer

A high-frequency galvanometer that extends the useful recording capabilities of CEC oscillographs to 13,000 cps has been developed by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell.

With the Type 7-365, oscillographs can be used for both "quick-look" monitoring and storage of data at frequencies heretofore attainable only by such equipment as cathode-ray oscillographs and magnetic tape recorders.

The 7-365 has a rated deflection (ac peak-to-peak) of one inch double amplitude and can be used with all CEC oscillographs having an 11½-in. optical arm.

Total sensitivity variation over the entire frequency range (at rated deflection) is not more than ±5% from the statistically determined frequency-response curve.

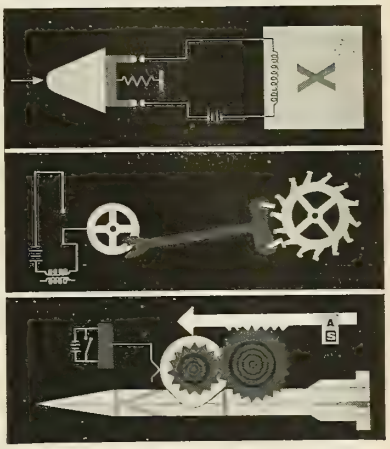
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## Polyethylene Adhesive

An adhesive to bond polyethylene plastics has been developed by Northrop Corp., Ventura Div. The polyethylene plug melts when exposed to heat, enabling gas pressure to escape through the opening eliminating any danger of sustained rocket motor operation during storage.

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**2 SPACE PROPULSION SYSTEMS**
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**3 PROGRAM MANAGEMENT**
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**William H. Russell:** Elected executive vice president of Technical Measurements Corp., North Haven, Conn.

**John C. Barnes:** Appointed vice president of engineering for the Hycon Manufacturing Co., Monrovia, Calif.

**Dr. Kenneth G. Halvorsen:** Appointed technical director of Beckman Instruments, Inc., Fullerton, Calif.

**Herbert A. Finke:** Vice president and general manager of Bomac Laboratories, Inc., Palo Alto, Calif., elected a vice president of Varian Associates.

**E. H. Usher:** Appointed director of sales for the Electronics, Magnetics and Research Divs. of Automation Industries, Inc., Boulder, Colo.

**Paul M. Hachigian:** Appointed director of engineering of International Electric Corp., Paramus, N. J.

**J. G. Scherer:** Named vice president and general manager of Wean-McKay of Canada, Ltd., Galt, Ontario, Canada.

**Larry S. Winston:** Appointed aerospace ground equipment manager for Cleveland Pneumatic Industries, Inc., Cleveland.

**Paul S. Collins:** Formerly with Hughes Aircraft Co., joined the Electrada Corp., Los Angeles, as vice president, corporate planning and product development.

**Robert P. Sumberg:** Appointed manager of Avco Corp.'s Lawrence, Mass. facility.

**Welcome W. Bender:** Appointed director of research of the Martin Co.'s Research Institute for Advanced Study, Baltimore.

**William H. Graham:** Elected president of North Electric Co., Canton, Ohio.

**Dr. Rudolf E. Kalman:** Staff scientist at the Martin Co.'s Research Institute for Advanced Study, named by the Maryland Academy of Sciences as the Outstanding Young Scientist of 1962.

**Robert B. Luirette:** Named director of manufacturing by Thompson Ramo Wooldridge, Inc.'s Space Technology Laboratories, Redondo Beach, Calif.

**John G. Hazard:** Named general manager of the North American Aviation Space and Information Systems Div. office at Cape Canaveral.

**Morris R. Lynn:** Appointed operations manager of Airtek Dynamics, Inc., Compton, Calif.

**John R. Lombardo:** Elected vice president-production of High Vacuum Equipment Corp., Hingham, Mass.

**Evan Ragland:** Appointed manager of Motorola, Inc.'s Teledata Laboratory, Chicago.

**George G. Hoberg:** Elected president of Monitor Systems, Inc., Fort Washington, Pa.

**Rex L. Brouillard:** Appointed manager of program administration at General Dynamics/Electronics, San Diego.

**C. T. Hardenburg:** Appointed director of quality assurance and reliability for Hayes International Corp., Birmingham, Ala. R. B. Hezlep appointed manager of quality assurance.

**George R. Tallent:** Promoted to director of reliability and quality control for Motorola Semiconductor Products, Inc., Phoenix.

**Jack B. Hippler:** Appointed manager of aerospace development sales of Lockheed-Georgia Co., Marietta, Ga.

**Thomas C. Clark, Jr:** Appointed director of marketing for the Space-General Corp., El Monte, Calif.

**Dr. Wilbur H. Goss:** Assistant director, Applied Physics Laboratory, Johns Hopkins University, awarded the Howard N. Potts Medal for his engineering designs and technical supervision leading to the development of the first successful supersonic ramjet and for his development of the ramjet combustion systems and integration of these systems in military vehicles.

**Ralph B. Dinsmore:** Named general manager of Angus-Sloane Associates, Moorestown, N. J.

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# —when and where—

### OCTOBER

**Society for Experimental Stress Analysis, Annual Meeting and Exposition,** Hotel Schroeder, Milwaukee, Oct. 24-26.

**Seventeenth Midwest Quality Control Conference, American Society for Quality Control,** Denver Hilton Hotel, Denver, Oct. 26-27.

**Fourth Annual Western Technical Conference, American Institute of Electrical Engineers,** Biltmore Hotel, Los Angeles, Oct. 29.

**The World Metal Show and National Metal Conference,** New York Coliseum, New York City, Oct. 29-Nov. 2.

**Meeting on Large Rockets, IAS,** El Dorado Inn, Sacramento, Calif., Oct. 29-30.

**American Society of Safety Engineers First Technical Conference,** Morrison Hotel, Chicago, Oct. 29.

**Twelfth Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers, Inc., a division of Sperry Rand Corp.,** Pick-Ft. Shelby Hotel, Detroit, Oct. 29-30.

**Symposium on Dynamics of Manned Lifting Planetary Entry, sponsored by General Electric Co. and AFOSR,** Philadelphia, Oct. 29-31.

**Combined National Fuel & Lubricants. Powerplant & Transportation Meetings,** Bellevue Stratford Hotel, Philadelphia, Pa., Oct. 29-Nov. 2.

### NOVEMBER

**Annual Southeastern Regional Meeting of American Chemical Society,** Gatlinburg, Tenn., Nov. 1-3.

**New Mexico Section of ASME Symposium,** University of New Mexico, Albuquerque, N. M., Nov. 2-3.

**Protection Against Radiation Hazards in Space Symposium, sponsored by the Oakridge National Laboratory and NASA,** Gatlinburg, Tenn., Nov. 2-7.

**Seventeenth Annual Meeting and Space Flight Exposition, sponsored by ARS,** Pan Pacific Auditorium, Los Angeles, Calif., Nov. 13-18.

**ASME Winter Annual Meeting,** Statler Hilton Hotel, New York City, Nov. 25-30.

**American Nuclear Society and Atomic Industrial Forum, Winter Meeting and Atom Fair,** Sheraton-Park and Shoreham Hotels, Washington, D. C., Nov. 26-28.

**American Institute of Electrical Engineers, Machine Tools Conference,** Statler Hilton Hotel, Detroit, Mich., Nov. 26-28.

**Environmental Testing Seminar, sponsored by Gulton Industries, Inc.,** Metuchen, N. J., Nov. 26-30.

**Human Factors Society Annual Meeting,** Barbizon-Plaza Hotel, New York City, Nov. 28-30.

**1962 Ultrasonics Symposium, Institute of Radio Engineers,** Columbia University, New York City, Nov. 28-30.





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# DOD Takes a Stand

SLOWLY, almost imperceptibly, the climate for an effective military space program is improving.

The military space program itself has not yet felt the effects of this. What we are discussing here is the atmosphere necessary to creation of such a program. This atmosphere is tenuous—but a necessary prelude to action.

Like all such vapors, it can be whirled away by a puff of wind from the wrong direction. But today it is there. Whether it solidifies into something more tangible remains to be seen.

It exists for a number of reasons. The President's speech at Rice University during his tour of missile/space installations gave more Administration support to military space efforts than his previous declarations. Congress adjourned with a greater awareness of the need for a military space program. The Dept. of Defense itself has defined its position more clearly—and this in itself is progress.

We carry in the pages of this issue two very important documents delineating DOD's military space philosophy. One is an interview with Secretary of Defense Robert S. McNamara by *Newsweek's* able Pentagon correspondent, Lloyd Norman. *Newsweek* reported some of the Secretary's comments in its recent Space issue. Because of the importance of the subject, MISSILES AND ROCKETS asked Dept. of Defense and *Newsweek* for permission to print the full text of the interview.

It is a document of major importance to the industry. This is the first time Secretary McNamara has consented to an interview which places his views on military space clearly and firmly on the record.

The second document is the text of a speech by Asst. Secretary John Rubel which outlines the complete DOD philosophy on military space.

Taken together, the two articles provide as clear a definition of the Administration's views in this field as could be desired. We certainly do not agree fully with the stand taken. Some of Mr. Rubel's arguments would have made an effective case against building the Wright brothers' airplane.

But, at the least, we now know where we stand. In the past, arguments about the DOD space philosophy necessarily have been based too much on hypothesis. We are grateful to both gentlemen for clarifying the DOD position.

That position, as we said, seems to have improved somewhat. Even the adamant Mr. Rubel has modified his views slightly. Secretary McNamara's remarks, while cautious, could be termed downright hopeful in light of the past DOD position.

Again, this hope admittedly is based on a few straws which could be blown away by an adverse wind. Mr. McNamara states: "At this time, I see no *clear* requirements for manned satellites for military purposes." The italics are ours and the very appearance of the word "clear" is progress.

The Secretary's statement that he would favor a manned orbital development station for the Air Force if it will add anything substantial to the *X-20* and *Gemini* programs also is a gain. It is far from a commitment and leaves the way clear for a negative decision. But the public admission that such a program *may* be worthwhile can be classed as overwhelming enthusiasm in contrast with some past DOD views.

There is no doubt that the mounting of an extended military space program alongside the existing multibillion-dollar NASA effort would place a burden on the economy of this nation. We disagree with DOD and the Administration on the willingness and ability of the American people to support this burden. We disagree also on the amount of military benefit that can be expected as "fallout" from the NASA effort.

There are signs that the military role in the *Gemini* program will be increased significantly. This is encouraging.

But more encouraging is the still tentative approach being put forward in public statements by high Air Force officials. Increasingly, they are referring to the need for a defensive space capability. We would like to see this become the theme for an all-out campaign.

FIFTEEN YEARS ago, if the Navy had pushed vigorously for all the equipment needed for antisubmarine warfare, it probably would have more aircraft today than the Air Force—and an extensive space program to boot. Instead, it dissipated its energy in a battle with the Air Force for the strategic bombing role.

The Air Force should learn from this. There is no doubt of the need for a strong military defensive capability in space against potential Soviet weapons. Let the Air Force press strongly for this capability. It is politically palatable, both nationally and internationally. It will find strong Congressional support.

In establishing this defense, the Air Force will obtain 90% of the capability it requires for offensive programs, when and if needed.

Meanwhile, the NASA program can fulfill peacefully the offensive requirement—taking the high ground by scientific, rather than military, technology.

The way to this approach has been opened by the DOD clarification of its position. Until a stand is taken, there can be no debate. Without debate, there can be no progress.

We congratulate Mr. McNamara and Mr. Rubel for their contribution to this progress.

**William J. Coughlin**

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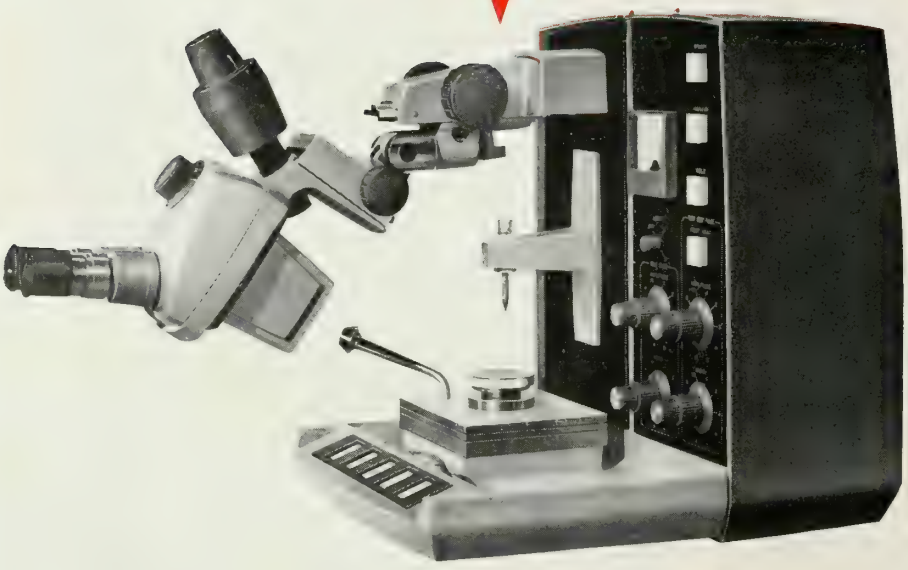
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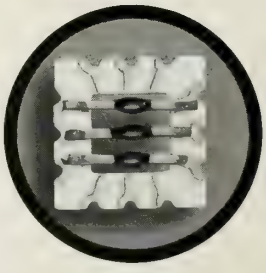


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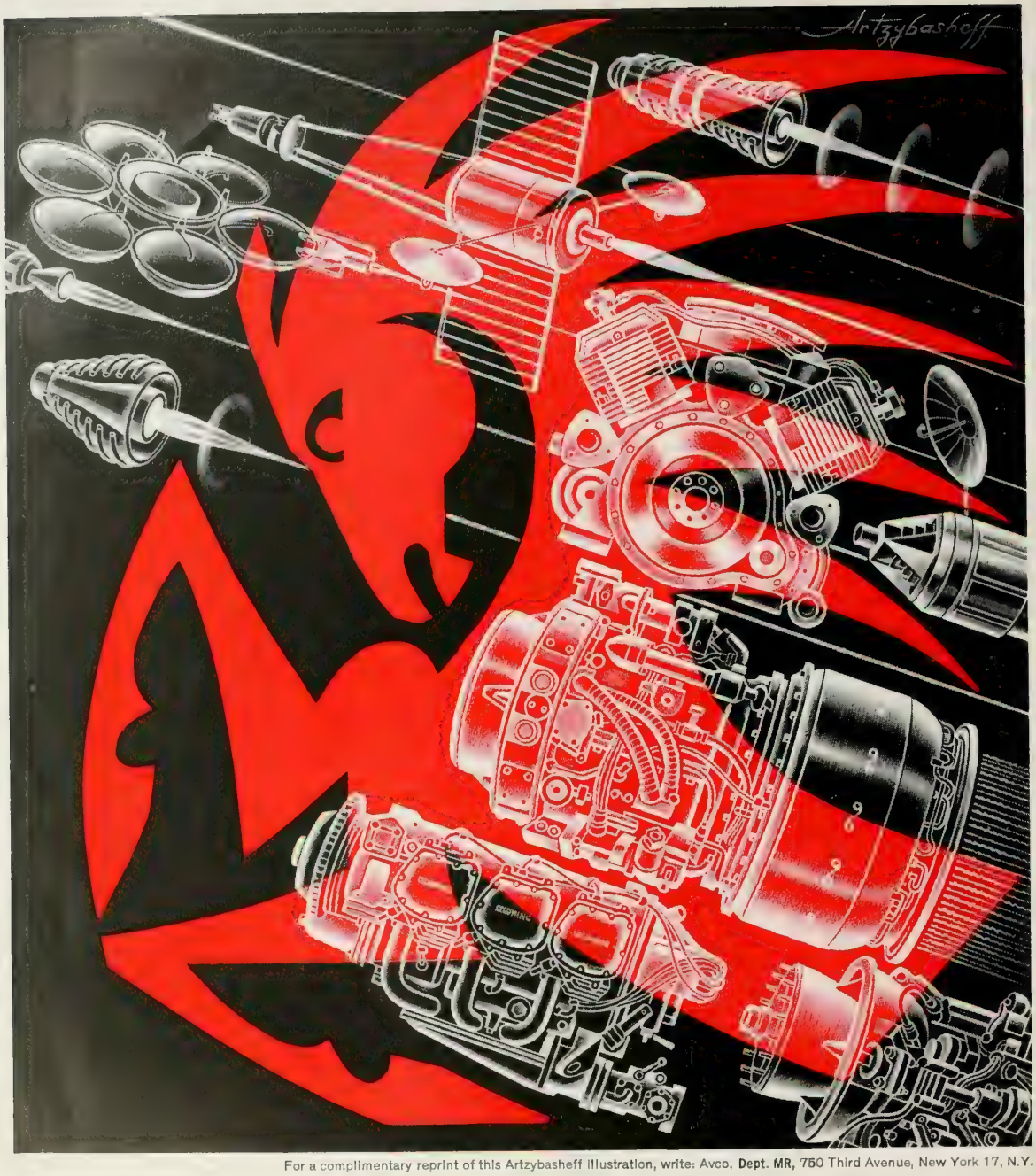
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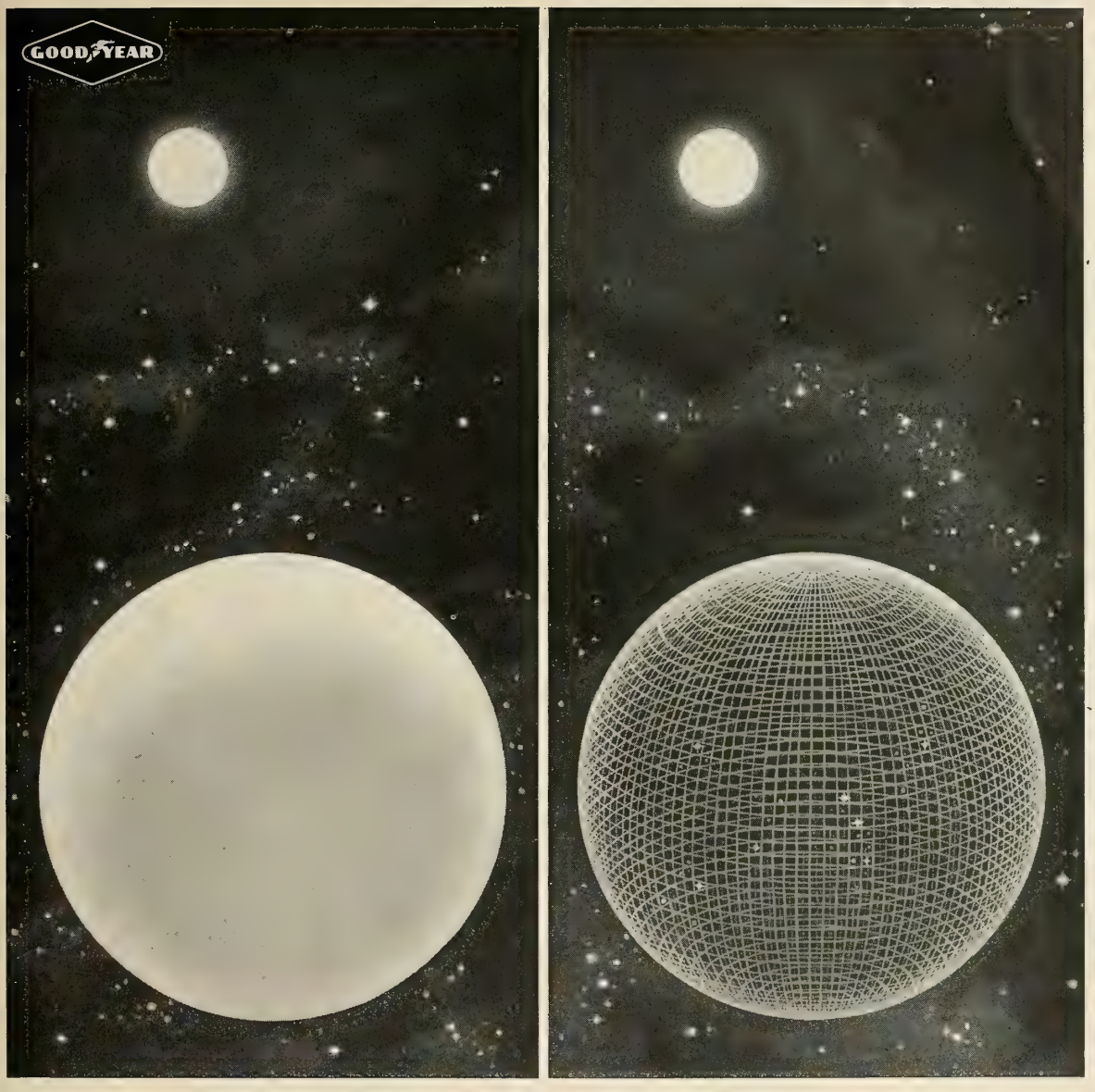

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# *RAYTHEON'S NEW SPARROW III GOES AIR FORCE*

Already the U. S. Navy's prime air-to-air missile system, Raytheon's Sparrow III has now been selected by the U. S. Air Force for use on its F-4C tactical fighter.

The advanced Sparrow III which will be used by the Air Force is the result of a growth program that has seen major improvements phased in since the missile was first conceived in 1951. These improvements include substantial increases in range, speed and altitude capabilities.

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Sparrow III is further proof of Raytheon's ability to manage complex military systems — from early study through design, production and field support.

RAYTHEON

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 18 October 29, 1962

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## THE COVER



*Sperry Sergeant missile underwent its first tactical field firing by Army personnel at White Sands Missile Range Oct. 24. Photo shows installation of snap-on fins, last step in assembly. See p. 16.*

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†U.S. Reg. Pdg.

*44,136 copies this issue*

# —letters—

## Shape of the Moon

*To the Editor:*

Your Oct. issue cover caption reads "First Photo of Moon's True Shape," on a photograph taken July 31 showing the lunar silhouette against the background of the Sun's disc.

Such photos of "annular" solar eclipses have been made for at least 50 years by astronomers the world over, using long-focus optics of extreme precision. It is questionable whether the sharpness or resolution of the subject photo is substantially better than many similar photos previously made, although I'll take the word of any professional astronomer as to this.

In any event, the lunar "limb" shown cannot be considered as average for the entire lunar surface. It represents only the one "meridian" of lunar longitude apparent at the time of a specific lunar libration position, both in latitude and longitude.

Indeed, there is considerable support for the theory that the Moon as a whole, due to mutual gravitational interaction with the Earth and the fact that its keeps substantially the same face always towards us, is much more egg-shaped than spherical, with the long axis pointed toward Earth.

Further, it is difficult to understand how such photos can be used to establish "an average altitude of lunar sea level" except over a very narrow selenographic band. Also, extrapolation from such a photo, to calculate "lunar gravity effects" outside of such a band, can only be the domain of a "lunatic."

Until this matter is more fully explained, I am withholding my application to become a luna-naut.

G. V. Plachy, F.R.A.S.
Sr. Mem. Amer. Astronaut Soc.
Woodside, N. Y.

## Back-Copy Gap

*To the Editor:*

Immediately upon receipt of my Aug. 27 M/R, I noticed Mr. M. J. McCaslin's letter on p. 6, and at once sent him an air-mail letter regarding the back copies of your excellent publication.

I was the first man on base and I am to get Mr. McCaslin's copies from Vol. 1, No. 1 to the two July, 1958 issues.

I wonder if you can possibly help me to complete my run of MISSILES AND ROCKETS from August, 1958 to May, 1961. Perhaps you could help me via the letters column. Could you? Would you?

In the past, I have written several correspondents in your letters column, but have had no success in locating a source of supply for back copies.

Horace D. Westbrooks
415 West Slaton Ave.
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Griffin, Ga.





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## Superior Intelligence

*To the Editor:*

Regarding your Aug. 27 editorial, "Playing with Blocks," and the subsequent letter from Thomas D. Ross (criticizing the *Polaris* program) in M/R, Sept. 10, may I refer you to statements by Rep. George P. Miller (D-Calif.), chairman of the House Space Committee, in a speech before the House on Sept. 6.

Rep. Miller struck back at the "Monday morning quarterbacks" of military space by saying: ". . . our defense officials are not dolts, and I suspect that their decisions are based on information and intelligence which is somewhat superior to that of their lay critics."

I might add that it is baffling to me how anyone can call the greatest advance in both Naval history and missile technology a "toy."

John W. Wasik
Missiles & Space Staff Writer
Daily Times
Melbourne, Fla.

*The "toy" designation for Polaris was Reader Ross's, not ours.—Ed.*

## Actual Uncertainty

*To the Editor:*

May we express our appreciation for your selection of our new Pyrometric Molarc equipment as the "New Product of the Week" in the Oct. 15 M/R.

There is a technical error in the second sentence of the published article due to the omission of a plus sign. This sentence should read, "Its absolute brightness temperature is 3803°K with an uncertainty of ±20°."

The nature of the error is such that it could not be construed to be detrimental to the equipment, but implies that the uncertainty of the temperature value is only one half the actual uncertainty. The true performance characteristics will, of course, be clearly presented in the literature which will be forwarded to interested readers.

Thank you again for the fine article.

M. A. Hankins
Vice President, Engineering
Mole-Richardson Co.
Hollywood, Calif.

## Readability Valued

*To the Editor:*

You are performing a major service to our country by the content of your editorials.

M/R is one of the finest and most readable magazines I subscribe to. It's kept *simple so it can be read*—unlike too many "technical" papers. Am enclosing my check for two years' subscription—the first time to do this in years—a tribute to you and your magazine.

R. G. Crowder
Little Falls, N.J.

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Mysterious cloud patterns that stay the same for weeks on end blanket the face of Venus. What are they and what's behind them? What is the 30,000 mile long "Red Spot" that drifts longitudinally in Jupiter's cloud system? Saturn's nine moons? To answer these and a host of other questions, Princeton University will send Stratascope II aloft to 80,000 feet, above 96% of the earth's atmosphere. It will carry a radio-controlled photo-telescope that has an optical system capable of distinguishing two objects 30 inches apart at 1,000 miles.



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# The Countdown

## WASHINGTON

### Cuban Threat Lends Zeus Emphasis

Insiders say the *Nike-Zeus* anti-ICBM system also is capable of intercepting Soviet missiles such as those based in Cuba. Its design requirements include intercept of missiles launched from submarines near the U.S. coasts. Proponents point out that early approval of long-lead-time production components would have put deployment of the system months away—instead of years, as at present.

### NASA Denies 18-Orbits Planned

Despite press reports referring to an 18-orbit *MA-9* mission, NASA headquarters officials report the next *Mercury* flight will last only 24 hours. This would limit the flight to 16 or 17 orbits at most.

### Nova Development Off Until 1965

It now appears certain that hardware development of the *Nova* superbooster will not begin until Fiscal 1965. Budget limitations have killed NASA hopes of getting the project under way in the second half of FY '64. Prospects now are for a $5-million study effort during the coming fiscal year.

### Hercules Improvements Pose Problem

Improved capability of the Army's *Nike-Hercules* against bombers and air-to-surface missiles means tactical locations of the missile batteries no longer are optimum. Proposals to relocate some of these are being studied by the Defense Dept.

### Aerospace Plane to Cost Half Billion

NASA officials estimate total cost of a study and development program for *Aerospace Plane* at $500 million—twice the cost of the *X-15* program. Top Air Force leaders are emphasizing the system as essential to economical, repetitive, around-the-clock space operations. Both NASA and AF are hard at work outlining an *ASP* study program.

### Major Effort Set for Project MINT

Within the past month, Project MINT—Materiel Identification and New Item Control Techniques—has become a major effort of the Air Force Logistics Command. Objectives: to eliminate unneeded items and correct identification errors of items in the AFLC inventory as well as improving control of new items. Some 1300 technicians are at work on the program, which is expected to cut AFLC inventory by 30%.

### NASA Plans Another Lunar Seismometer

NASA plans to repeat its attempt to put a seismometer on the Moon. The experiment was part of the *Ranger V* flight which missed the Moon due to power failure. U.S. scientists believe the seismometer will reveal more information about the Moon than lunar photographs.

### Equatorial Site Still on the Map

Although Dept. of Defense officials continue to insist the U.S. has no need for an equatorial launch site, latest official maps of the Pacific Missile Range still show Manus Island as a potential site for injection of satellites eastward into equatorial orbit.

## INDUSTRY

### Boeing Set for Big Saturn Contract

Detailed contract with Boeing Co. for the first stage of the *Advanced Saturn*, due for signing by NASA within a few weeks, will cost well over the preliminary estimate of $300 million. Contract will cover development through 1966.

### Skeen Seen as AIA President

Clyde Skeen, executive vice president of Ling-Temco-Vought, has the inside track for the presidency of Aerospace Industries Assn. The post has been vacant since the May 15 resignation of August Esenwein. The new president will be named at the Nov. 7-9 board of governors meeting in Phoenix. Skeen, an expert on renegotiation, is a former Boeing vice president.

### Pickering to Head Merged ARS-IAS

Presidency of the American Institute of Aeronautics and Astronautics will go to ARS President Dr. William H. Pickering if the proposed merger of American Rocket Society and Institute of Aerospace Sciences into AIAA is approved. Members must vote on the merger by Dec. 7. The new society, if approved, will come into existence next Feb. 1. To effect the merger, more than 50% of those entitled to vote in each society must vote and more than two-thirds of those voting in each society must vote to ratify.

### Sylvania Alarm System Under Test

The first "burglar alarm" for missile silos has been accepted for evaluation by the Air Force. Plans call for shrouding each silo with a dome-like blanket of electromagnetic radiation which will sound an alarm if disturbed. Sylvania Reconnaissance Systems Laboratories holds a $2-million contract for development of the system.

## INTERNATIONAL

### Germans to Call for Rocket Bids

West German firms soon will be invited to bid on the third stage of Western Europe's first space rocket. Eight vehicles are to be built, with the first ready in 1966. As previously announced, first stage is to be Britain's *Blue Streak* with the French *Véronique* as second stage. Italy will build the satellite.

### First British Missile Ship Due

Commissioning of the first British guided missile destroyer, H.M.S. Devonshire, is set for Nov. 15. The 5200-ton vessel will carry *Seaslug* missiles on the quarterdeck and *Seacat* close-range missile abaft the aft funnel.

### Nord, Boelkow Sign Agreement

Germany's Boelkow-Entwicklungen and France's Nord Aviation have signed an agreement for joint missile development and production. The two firms will hold meetings alternately in Munich and Paris.

## 'Dominic' Using Solid Rockets

The two launch vehicles newly introduced into high-altitude nuclear tests being conducted in the Pacific are both solid-fueled rockets—*Nike-Hercules* and *Sergeant*.

*Sergeant* was used in a successful test Oct. 20 (See Shots of the Week). First launch of *Hercules*, scheduled several times, has been plagued by a number of postponements.

Use of the solid-fueled missiles, according to a DOD official, resulted in a degradation in the planned weight of the nuclear test devices.

Though *Thor* was successful in only two of six launches from Johnston Island, it has not been eliminated from the program. *Thor* is expected to be used to loft the final device of the test series, following the *Nike-Hercules* launching.

A DOD official said the poor Pacific test record of the usually quite reliable *Thor* was partly due to its unusual application and to extremely rigid safety requirements for the nuclear payloads.

## LEM Contract Soon

NASA will very shortly let a contract for the Lunar Excursion Module in its *Apollo* program.

NASA Administrator James E. Webb disclosed the plan in a talk last week to members of the European Broadcasting Union.

Webb's statement may mark the end of disagreement as to the best approach to the Moon. Presidential science advisor Jerome Wiesner had questioned the lunar orbit method's superiority, but NASA officials reportedly have convinced him of LEM's merit.

## AF Orders Atlas SLV

Air Force has awarded a contract to General Dynamics/Astronautics for a standardized *Atlas* space launch vehicle (SLV).

The vehicle will be known as *Atlas SLV-III*. The contract, estimated to be worth $78 million, covers design and development of a standard space launch version of the Air Force *Atlas* ICBM, modifications to *Atlas* launch pads at the Atlantic and Pacific missile ranges, and production and launch of *SLV-III* boosters (M/R 10/15, p. 9).

The *SLV-III* will consist of the basic *Atlas* airframe and the Rocketdyne liquid-propellant three-engine cluster. The engines are being boosted from 360,000 lbs. thrust to about 390,000 lbs. Standardized guidance, electrical system autopilot, tracking and telemetry kits will be provided.

The Air Force *Atlas SLV-III* combined with the *Agena* upper stage will be able to boost payloads weighing from 2000 to 6000 lbs. into a low Earth orbit.

## Shots of the Week

• The Air Force is investigating a *Minuteman* ICBM failure eight seconds after launch from Cape Canaveral on Oct. 17.

After its destruction by the range safety officer, flaming debris from the solid-fuel missile fell back


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onto the Cape complex. Resulting fires included one in Complex 26, where a *Jupiter* on the pad was damaged.

Explosion damage estimates were in tens of thousands of dollars—mainly for cabling and support equipment around the *Jupiter*. A two-ft.-dia. hole burned in the missile has forced indefinite delay of the *Jupiter* launch.

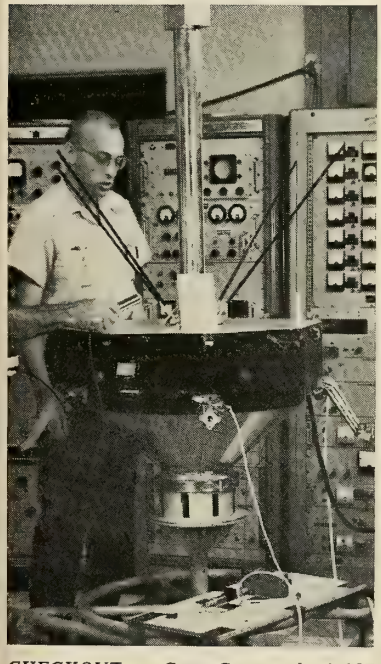
• An *Atlas F* ICBM successfully fired from Cape Canaveral Oct. 19 traveled more than 4000 miles down the Atlantic Missile Range. The missile was launched by an all-AF crew to obtain statistical flight data.

• *Cosmos XI,* latest of the Soviet space research satellites, was launched Oct. 20. Its apogee, according to the Soviet news agency Tass, is 572 mi. Perigee is 152 mi., and its period is 96.1 min.

• A specially built missile—powered by a *Sergeant* booster—carried a nuclear device to an altitude of 20-30 mi. over Johnston Island on Oct. 20. The high-altitude nuclear device was in the low-yield range—less than 20,000 tons of TNT.

• In a test Oct. 23 to determine whether removal of the ventral fin improves re-entry stability during return from space, *X-15* pilot Maj. Robert Rushworth delayed using the plane's speed brakes until after engine burnout. The 88-sec. delay threw the plane into a ballistic path for the re-entry test. The *X-15* reached an altitude of 134,000 ft. and a speed of 3818 mph.

• A 300-mile flight by *Pershing* on Oct. 22 marked the first time in Cape Canaveral's history that a ballistic missile was fired from other than a prepared concrete pad. Tactical equipment in vans was used for power and countdown, while the regular blockhouse merely monitored the test.



*CHECKOUT at Cape Canaveral of S3B satellite, which was scheduled to be launched Oct. 26. Satellite will follow a highly elliptical orbit, ranging from 170 to 10,360 miles, to study artificial radiation belt created by July 9 U.S. high-altitude nuclear test.*

## Second Delay for ANNA

Launch of *ANNA*—the DOD/NASA geodetic satellite to have been shot from Cape Canaveral Oct. 24—was postponed for the second time.

The Pentagon said it was decided to delay the *ANNA* firing until after the launch of *S3B,* the radiation-measuring satellite, scheduled for Oct. 26.

## NASA Readies Patent Rules

NASA will announce this week new patent licensing provisions covering inventions developed under its R&D contracts.

The regulations will detail procedures to be used by missile/space firms seeking the right to use NASA-owned patents.

At the same time, the space agency will publish a proposed "waiver regulation" under which NASA in certain instances will waive its rights to the title of patents. A hearing will be held Dec. 10 to get industry opinion on the merit of the proposed regulation.

## Aerospace Pilots Picked

Ten more Air Force pilots were picked for the Aerospace Research Pilot School Advanced Course at Edwards AFB, Calif. The eight-month course is designed to develop pilots for such aerospace projects as the *X-20 Dyna-Soar* and follow-on programs.

Pilots named were: Capt. Alfred L. Atwell, North Garden, Va.; Capt. Charles A. Bassett, Berea, O.; Maj. Tommie D. Benefield, Jefferson, Tex.; Capt. Michael Collins, Alexandria, Va.; Capt. Joe M. Engle, Chapman, Kans.; Maj. Neil R. Garland, Hicksville, N.Y.; Capt. Edward G. Givens, Quanah, Tex.; Capt. Francis G. Neubeck, Washington, D.C.; Capt. James A. Roman, Paris, France; and Capt. Alfred H. Uhalt, New Orleans, La.

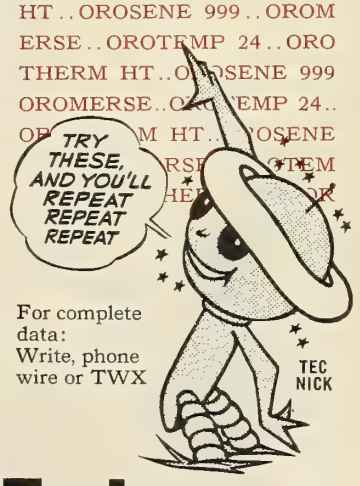
*(Continued on page 47)*





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# Cuba Missile Threat Detailed

***MRBM's resembling T-4 in place at bases; cruiser-type IRBM's depicted in drawing***

**by James Trainor**

MORE THAN 30 Soviet medium-range ballistic missiles now are operational at eight to ten bases in Cuba, according to latest Dept. of Defense estimates.

Intelligence sources place the Cuban missile sites near the cities of Guanajay, Remedios, San Cristobal and Sagua La-Grande. Each base has in the neighborhood of four launchers.

Examination of line drawings and reconnaissance photographs released by DOD indicates the MRBM threat to the U. S. to be far greater than that of Soviet intermediate-range ballistic missiles, which also are being deployed on the Caribbean island.

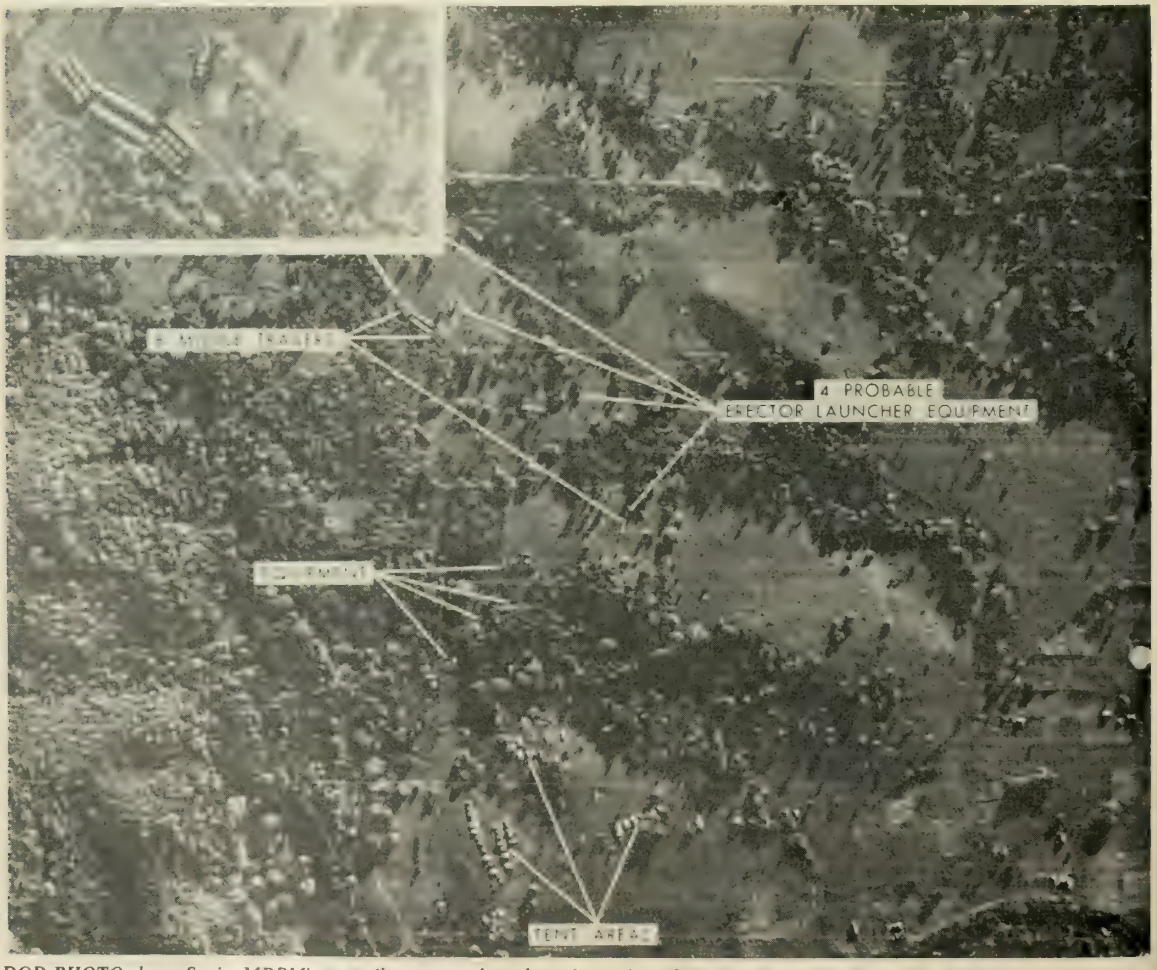
The Soviet IRBM's in the drawings appear to be air-breathing vehicles of the *Mace-Matador* class but with greater range. Cruise missiles such as these could be intercepted by the U. S. *Nike-Hercules*.

DOD officials declined to comment on the capability for such interception and would not, in fact, confirm the air-breathing nature of the Soviet IRBM's.

No IRBM's appear in the reconnaissance photos, although site preparation for them is evident.

DOD officials declined to identify any of the Soviet missiles in the photos or drawings, which also included surface-to-air and sea surface-to-surface weapons.

But the medium-range missile appears to be the Soviet's *T-4*—an improved and smaller version of the *T-2* IRBM. The two-stage *T-4* is about 53




*DOD PHOTO shows Soviet MRBM's on trailers next to launchers. Inset gives closer view.*

ft. long and can carry an 1800-lb. nuclear warhead. Both stages use LOX/alcohol propellants. The first stage engine is the R-14, which develops over 200,000 lbs thrust. The second stage uses one R-10 with approximately 78,000 lbs. thrust. The U. S. has no missile of comparable characteristics in its arsenal.

The IRBM seems to be a type not yet shown publicly by the Russians. In the configuration released by DOD, it appears to be similar to the improved version of the *Mace*. It is possible that the IRBM is the *T-5A*—a solid-fueled, guided missile about which little is known.

The surface-to-air missiles appear from the recon photos to be *T-8's* with a range of 15-25 miles at a speed of Mach 2.5. The ceiling of these weapons is approximately 79,280 ft. The first stage of the 13-ft.-long missile consists of a cluster of two solid-fueled boosters with a thrust of 4000 lbs. The second stage—liquid-propelled—develops 4000 lbs. thrust. Employing an HE warhead with a proximity fuse, the missile has been sighted in East Germany in its characteristic deployment pattern of six launchers.

Although designed as a surface-to-air missile, the *Golem III* most closely approximates the visible characteristics of the two missiles carried by the Komar motor patrol boats. Armed with a conventional warhead, *Golem III* has a range of 10 miles and, in its surface-to-air role, a ceiling of over 65,000 ft. The solid-fueled missile is over 15 ft. long, 20 in. dia. and weighs approximately 4500 lbs.

Deployment of the systems gives the Soviets a nuclear strike capability against the Western Hemisphere. The extent of the threat was graphically illustrated by the President in his Oct. 22 television address when he pointed out that the 1000-mi.-range MRBM's are capable of striking Washington, D. C., the Panama Canal, Cape Canaveral, Mexico City or any other city in the Southeastern part of the United States, in Central America or in the Caribbean area (M/R, July 18, 1960, p. 51).

The 2200-mi.-range IRBM's, he said, could hit most of the major cities in the Western Hemisphere, ranging as far North as Hudson's Bay, Canada, and as far South as Lima, Peru.

• **Details revealed**—To support the U. S. contention that these offensive weapons were in fact being deployed, the Defense Department released its series of aerial photographs showing the missile sites in various stages of construction.

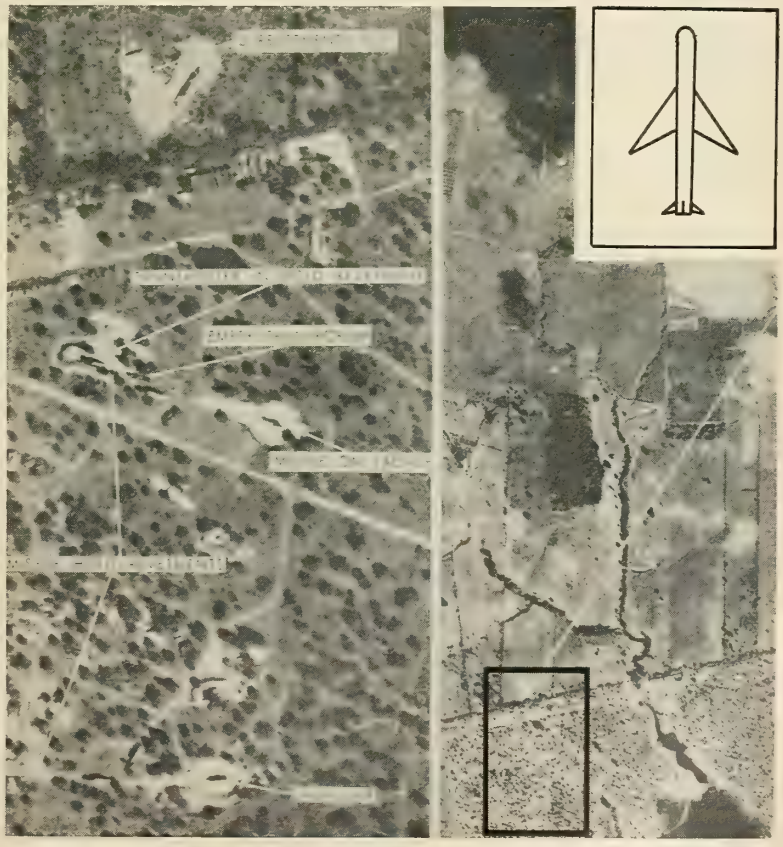
In a briefing following the President's signing of a proclamation authorizing interdiction of the delivery of offensive weapons to Cuba, Secretary




*ANOTHER MRBM BASE snapped in aerial photograph series.*



*SOVIET MRBM shown in Moscow parade earlier this year.*



*RECON SHOT of cruise IRBM base being built. Drawing shows configuration.*

## Nuclear warhead presence assumed . . .

of Defense Robert S. McNamara outlined the characteristics of the offensive threat.

The MRBM's, he said, are mobile and have a capability to be deactivated, moved, reactivated on a new site and ready for operations within a period of about six days. These missiles—some of which are ready to fire now—have a range of more than 1000 n.mi. and carry a medium-size nuclear warhead. (A medium-size warhead, in U. S. parlance, is in the 20kt-lmt range.)

(Earlier, a Defense spokesman gave a more detailed description of the MRBM's. The launchers, he said, were aligned to a specific section of the U. S. MRBM's are taken to the launch site aboard trailers which are moved to the launcher. The missile is then grasped by the launcher and erected, and the trailer moves away. Pre-surveyed, prepared sites are required, as well as missile check-out facilities.)

Turning to the IRBM's, McNamara pointed out that these missiles required fixed sites, which are now in various stages of construction. However, the Secretary made it clear that, as yet, none of the IRBM sites was operational.

"I am not prepared to say whether we have found that IRBM missiles are in Cuba," he said. "But IRBM installations and associated equipment are there. I am not saying that the missiles are or are not. I am simply not distinguishing between the missiles and the equipment."

The IRBM's, also carrying nuclear warheads, have a range of approximately 2200 miles. A Defense spokesman said four missile launchers of the IRBM category are being prepared at fixed locations with a control bunker between each pair. Cables link the control bunker to each missile in the pair. The IRBM sites are not hardened, according to DOD.

Both of the offensive weapons systems, a DOD spokesman said, are being manned and operated by Russians.

The high quality of the missile systems differs substantially from other weapons furnished by the Soviets to the Cubans or other satellites, a DOD spokesman said. Soviet MRBM's and IRBM's have not been provided to any satellite country heretofore, he noted.

### Crisis Won't Affect Canaveral Launchings

CAPE CANAVERAL—The Cape expects to carry on business as usual during the Cuban crisis.

Maj. Gen. Leighton I. Davis, commander of the Air Force Missile Test Center, said last week he expected the R&D program to continue without change. He told a news briefing that only the outbreak of war would alter the schedule.

• **Other missile systems**—Two other categories of missiles have been supplied to Cuba, the Secretary of Defense said. These include surface-to-air missiles associated with air defense facilities and sea surface-to-surface missiles mounted on patrol boats and used presumably in terms of costal defense against naval vessels.

The latter, a DOD spokesman said, are "a ship-directed missile, short-range, not of the type that you would expect to launch against a land target under anything but the most extreme circumstances." Mounted on Komar motor patrol boats, these missiles carry conventional, non-nuclear warheads and are used for coastal defense operations.

The surface-to-air missiles—also among the most modern of Soviet weapons—are employed in a six-launcher circular pattern with a control center located in the center. The "Fruit Set" radars used by the Soviets are located in close proximity to these emplacements.

In discussing nuclear warheads for the offensive systems, McNamara pointed out that "it is extremely difficult for us to specifically identify nuclear warheads. But I think in view of the fact that we know and have identified substantial numbers of missiles that can only operate with nuclear warheads it is fair to assume such warheads are on the island."

Earlier a Defense spokesman had told newsmen that "it is almost inconceivable . . . that there would be missiles . . . without accompanying warheads."

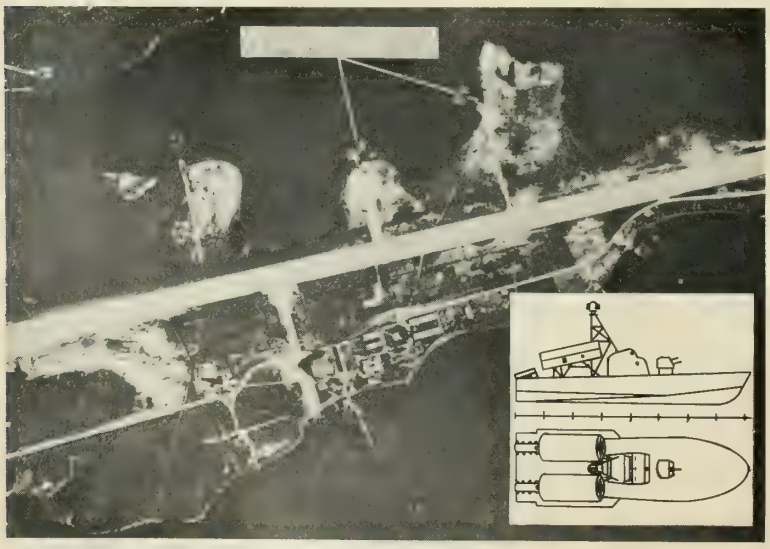
The seriousness of the threat was pointed up by one official's statement that the U. S. does not have the means to intercept this type of missile. "These are missiles that operate at speeds somewhat less than, but similar to, ICBM's and neither the Soviet Union nor we have operating anti-intercontinental or intermediate range ballistic missiles systems," he said.

• **U. S. countermoves**—To meet the threat, air defense units have been shifted to the Southeastern part of the U. S. Reportedly included in these moves were three *Hawk* battalions. These units along with *Nike-Hercules* battalions would be used to counter the threat posed by the IL-28 jet bombers also being deployed in Cuba.

The IL-28 is a medium-range jet aircraft with a radius of action of approximately seven or eight hundred miles. In contrast to the missile systems, the IL-28 are not modern aircraft; they were first produced in the early 1950's.

The quarantine presently in effect against importation of any further offensive weapons into Cuba covers "surface-to-surface missiles, bomber aircraft, bombs, air-to-surface rockets and guided missiles, warheads for any of the above weapons, mechanical or electronic equipment to support or operate the above items and any other classes of materiel" designated by the Secretary of Defense.

*(Continued on page 47)*



*DOD PHOTO of missile-launching PT boats on Cuban Coast. In inset are line drawings of boat with launchers (scale in tens of feet).*

***Despite five failures . . .***

# Expanded Ranger Series May Total 20

***Surveyor slippage to 1965 responsible for considering pushing program beyond presently scheduled 14 vehicles***

**by Chris Butler**

JPL scientists now plan an increased *Ranger* lunar spaceflight program calling for the launch of as many as 20 spacecraft.

The expanded schedule is being considered despite five straight *Ranger* failures, including the most recent on Oct. 18, when the *Ranger V* power system failed 8 hours and 46 minutes after launch. The vehicle missed the Moon by about 450 miles and went into orbit around the Sun.

Primary objective is to fill the unmanned lunar exploration gap created by delay in the *Surveyor* program.

Proposed payloads for the additional flights include facsimile pictures taken on the lunar surface and a study of possible interplanetary life.

Plans for additional spacecraft above the currently approved 14 were disclosed to MISSILES AND ROCKETS by *Ranger* program chief Newton W. "Bill" Cunningham.

Predicting that the hard-landing lunar spacecraft series would have a long life, Cunningham said that as many as 20 flights may be made.

Officials at NASA headquarters confirmed that additional flights were being discussed—even though the program was only recently increased from nine to 14.

They said, however, that other numbers besides 20 were being considered.

The officials reported that further *Ranger* flights will probably depend upon the schedule of the *Surveyor* spaceflight series. Originally scheduled for 1963, *Surveyor* has now slipped until early 1965 because of the problems in *Centaur* launch vehicle development.

Even the 1965 date is tentative. NASA now says that final scheduling will not be made until early next year when a review of the *Centaur* program is completed.

In addition, the first *Surveyor* flights will merely orbit the Moon. Attempts to soft-land experiments on the lunar surface will not be made until a year later.

Thus, further *Ranger* flights in 1965 could fill the gap before the *Surveyor* landing flights begin or further slippage occurs in its launch schedule.

The officially approved *Ranger* schedule now calls for launch of *Ranger VI* in the first quarter of 1963. Flights seven, eight and nine will follow at three-month intervals. In 1964, *Rangers X* through *XIV* will be launched.

*Rangers VI-IX* will each carry six cameras—two wide-angle and four narrow-angle. Payloads for *Rangers X-XIV* have not been determined, but it is expected that the six TV cameras and the balsa wood retro firing lunar impact capsule will be repeated in some of those flights.

• **Versatility**—In predicting a long life for the *Ranger* program, Cunningham said that a wide assortment of fact-finding missions can be assigned to the spacecraft and the lunar impact capsule.

"We have developed a bus, capsule, retro motor and radar altimeter," he said. "We can do many things with them."

Cunningham said several different types of payloads have been proposed for the 25-in. ball and that studies have been under way on at least two of these.

One of these advanced studies was made by the Aeronutronic Division of the Ford Motor Co. and the other by the Langley Research Center.

Both studies were done under contract to JPL.

The study performed by Aeronutronic, developer of the lunar impact capsule, covered design of a facsimile machine which can be housed in the 12-in.-dia. inner ball and become operational shortly after impact.

Cunningham said the equipment includes a system of lenses and mirrors to scan the lunar horizon and transmit facsimile pictures back to Earth.

The pictures are recorded in a series of lines in a manner similar to that used in transmitting news photos by wire.

The Langley study was directed toward developing a means of using accelerometers and a penetrometer to measure the hardness of the lunar terrain.

The penetrometer and accelerometers are mounted in the ball with equipment to transmit data back to Earth. The penetrometer measures the distance penetrated as a result of a specific thrust while the accelerometers determine the texture of the soil by reporting the rate of deceleration after being ejected from the capsule. ❖

## *Eight More Tiros Vehicles Planned*

ANNOUNCEMENT is expected in the near future of a procurement schedule for a *Tiros* Operational Meteorological Satellite system which may call for eight more satellites.

Weather Bureau sources indicate disclosure of the new program could come this week. Other government sources report it may take longer.

The NASA *Tiros* program originally called for eight satellites, of which six have already been launched.

Dr. S. Fred Singer, director of the Weather Bureau's Satellite Operations Center, has, however, called for six more launches to provide continuous coverage until the advanced *Nimbus* satellite is ready. Under the Singer plan, NASA and the Weather Bureau would each fund three of the satellites.

There is nevertheless a good chance that *Nimbus* may now slip into late 1964 or early 1965. Thus, both groups are giving serious consideration to increasing the *Tiros* program to 16.

The announcement will detail how many more satellites will be launched and which agency will fund them. In any case, NASA, through its Goddard Space Flight Center, will manage procurement for the program.

*70-minute countdown . . .*

# Sergeant Success Indicates Readiness

***First tactical firing by Army artillery of replacement for Corporal points to overseas deployment in early '63***

**by Charles D. LaFond**

WHITE SANDS MISSILE RANGE, N. M. —First tactical firing of the *Sergeant* missile by U. S. Army artillerymen has demonstrated the weapon's readiness for operational deployment.

The pre-launch countdown, which normally requires less than 45 minutes, was marred last week by a 25-minute hold caused by launcher difficulties. An air-transportability test with the full *Sergeant* system was cancelled because of a transport aircraft priority suddenly imposed in response to the Cuban crisis.

The solid-fuel *Sergeant,* with a 25-75 nautical-mile-range, is to replace the more cumbersome *Corporal.* The Oct. 24 shot went the full 75 miles. Thrust was 45,000 lbs.

This first firing by user troops was carried out by members of the 3rd Missile Batallion, 38th Artillery, Ft. Sill, Okla.—first of three *Sergeant* batallions organized this year.

• **Operational philosophy**—*Sergeant,* together with its highly trained Army operators, will be ready for overseas deployment early next year.

West Germany will purchase the system, according to an announcement made here last week. First elements of an expected 70 to 100 German technicians have already arrived here for *Sergeant* training. Details on the amount of the purchase and number of missiles involved were not immediately disclosed. The missiles are not likely to be built outside the U. S.

M/R has also learned that purchase of the *Sergeant* by other European nations is expected to be announced shortly. Among these are Belgium, The Netherlands and possibly Italy. The U. S. will retain control of nuclear warheads.

The system can deliver a nuclear, chemical or biological warhead. It is not designed for a high-explosive payload.

Completely air transportable, the system includes two missile-transport vehicles, two electronic test stations, a communications vehicle, plus the launch station and prime mover. All are highly mobile. With its high-energy, solid-fuel propulsion system and its all-inertial guidance, *Sergeant* is expected to be vastly superior to *Corporal,* which is liquid fueled and radio controlled.

The *Sergeant* mission, like that of its predecessor, will be to support a field army corps. Its capability places it operationally between the short-range *Honest John* or *Lacrosse* missiles and the much longer-range *Redstone* and *Pershing.*

The 3rd Missile Batallion was organized at Ft. Sill last May 19. This was the first Army unit to be trained and equipped with *Sergeant.* Two more battalions have since been organized at Ft. Sill: the 3rd Missile Battalion, 81st Artillery, and the 5th Missile Battalion, 77th Artillery.

While some Army officials still do not consider *Sergeant* the optimum field weapon, a follow-on program for a more advanced system does not exist. *Sergeant* is expected to be operational for at least 7 to 10 years, though it will undergo continual subsystem improvement.

• **Development history**—*Corporal* was deployed in Europe in 1955. However, the system lacked mobility and operational flexibility. It required 4 to 6 hours to set up and launch even under the best circumstances. With its fixed-program, radio-controlled guidance, *Corporal* was subject to electronic countermeasures.

The *Sergeant* R&D program was begun in 1955. Jet Propulsion Laboratory, developer of *Corporal,* was again selected to serve as R&D manager. Sperry




*SERGEANT firing position takes advantage of foliage for cover.*

**SERGEANT CONTRACTORS**

| | |
|---|---|
| Program Management | Army Missile Command, Redstone Arsenal |
| Prime Contractor (R&D and Production) | Sperry Utah Co. division of Sperry-Rand Corp. |
| Gas-Turbine Generators | AiResearch Manufacturing Co. |

**PRINCIPAL SUBCONTRACTORS**

| | |
|---|---|
| Solid-propellant motor | Thiokol Chemical Corp. |
| Gyroscopes, Warhead subsystems | Minneapolis-Honeywell Regulator Co. |
| Erector-Launcher | Ling-Temco-Vought Inc. |
| Transport Trailers | Fruehauf Trailer Co. |

Gyroscope Co. was picked to be a co-contractor for R&D in 1956, and prime contractor for subsequent system production.

Sperry built a separate facility—Sperry Utah Engineering Laboratory near Salt Lake City, Utah—in which to perform its part of the program. The facility is now known as Sperry Utah Co.

The entire R&D program was transferred to Sperry when JPL became a principal contractor for the National Aeronautics and Space Administration in July 1960.

System development encountered serious difficulties. The initial concept of such a tactical weapon system pressed the state of the art (in 1955-56) to the limit. Development of aerodynamic dragbrakes to control range was a major problem. The firing set also was beset with design difficulties that significantly retarded final development of the system. In addition, the program experienced more than its share of trouble in attempts to improve overall systems reliability.

• **A 5-ton bird**—The assembled *Sergeant* missile weighs roughly 10,000 lbs., including its 1600-lb. warhead. It is 31 in. dia. and 34½ ft. long.

Four principal assemblies comprise the missile: the solid-fuel rocket motor section (afterbody), the guidance and control section (center), the warhead (forebody), and four control surfaces that snap onto the rear portion of the motor section.

The rocket motor includes an igniter and ignition circuitry.

The guidance section contains a three-gyro stable platform, accelerometers, digital flight data processor and programer, platform electronics, control assembly and power supply. Petal-shaped drag brakes are extended and retracted as directed by the guidance system to compensate for variable motor-burnout time and to adjust range limits.

The guidance package is cylindrical, weighs 125 lbs. and is roughly 18 in. dia. by 2½ ft. long.

The four interchangeable fins or control surfaces provide aerodynamic stability and permit attitude control and limited flight-path maneuver.

Each fin is transported separately in a sealed container, as are the three missile frame sections. The containers are provided with special adapter connectors to permit automatic checkout without disturbing the seals.

A semitrailer transporter carries the motor and guidance sections; the remainder of the missile is carried in a warhead transporter.

• **The launching station**—All equipment required to remove, lift and assemble missile sections; to align the guidance platform and program the missile computer; and to launch the missile, is provided by the launching station.



*GUIDANCE SECTION being attached to rocket motor section. Warhead will be placed at forward end. Fins snapped onto motor section to complete assembly.*

The launching station is composed of a specially designed semitrailer, superstructure, azimuth orientation unit, firing set and enclosure, and a gas-turbine-driven electric generator set.

For support, the vehicle is raised and leveled about 18 in. above ground on three hydraulic jacks, one at the rear and two that are swung out on folded steel girders from each side of the forward end. This also permits removal of the prime mover from the firing area.

An electrohydraulically operated main boom lifts and holds the missile sections during assembly, and launches the weapon when raised to the firing position. Missile assembly, according to the Army, can be performed by a six-man crew in seven minutes.

Missile orientation is achieved with the Azimuth Orientation System, which is comprised of an Azimuth Orientation Unit (AOU), T2 reference theodolite survey target set, and a missile orientation target (see accompanying diagram).

The AOU is inserted into the guidance section to align the inertial platform on a computer firing azimuth. The theodolite is analogous to the aiming circle in conventional artillery. Survey parties extend survey control to a prescribed accuracy (minimum) of 1:1000 in position location, and direction is accurate to 0.3 mil at the firing site.

The firing set, located at the front end of the vehicle, is used to insert all target information and to perform on-line checkout up through the actual launch. It includes complete dual redundancy, with manual switchover in case of failure of one set.

Finally, the set controls the automatic firing of the missile, although a manual override is provided.

• **Checkout and repair**—Two service vehicles provide support through fourth-echelon maintenance. The Organizational Maintenance Test Station is used in the forward area and is assigned

*(Continued on page 37)*




MORGAN HILL, CALIFORNIA - Low erosion rate exit cone passes 100,000 pounds thrust for 135 seconds as huge 35-ton segmented solid-propellant flightweight booster is test fired by the United Technology Corporation for Air Force Space Systems Division. Extended duration firing paves the way for multi-million pound thrust rockets. ☐ In this significant solid-propellant achievement, a composite of U. S. Polymeric Poly-Preg graphite tape and silica tape showed uniform erosion rates well below those heretofore attained in large rocket firings.

U.S. POLYMERIC Chemicals, inc.

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AMPEX



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**Create rugged missile components and parts from this asbestos-phenolic molding compound . . . designed for tape winding or hand layup and ease of molding**

Johns-Manville Thermomat Tape produces components and parts that withstand tremendous heat and pressure. Providing thermal shielding and maximum resistance to flame erosion with uniform ablation, it meets extreme high-temperature demands in rocket and missile applications.

The tape is made of 100% ASTM grade-AAAA long, oriented chrysotile asbestos fiber, saturated with a phenolic resin meeting military specifications MIL-R-9299. Flexible and tacky before curing, the partially dried tape is extremely conformable. Good fiber dispersion provides maximum and uniform reinforcement to the cured Thermomat. The unique characteristics of the tape allow easy working together of joints and permit free flow of fiber during molding. Even in intricate configurations, non-fillouts and resin-rich areas are reduced to a minimum. Molded parts can be easily machined and finished into precision units with close dimensional tolerances.

J-M Thermomat Tape is available in a variety of styles with varying resin, asbestos fiber and additive contents to allow fabrication of components for specific applications. Many Thermomat styles, for example, contain various inorganic fillers for improved thermal performance. Elastomer-modified phenolic resin styles are available for fabricating semi-rigid to highly flexible parts. J-M can also provide compositions that result in extremely low finished-part density. Though specially designed for tape winding operations, the versatility of Thermomat Tape makes it readily adaptable for hand layup, and low- to high-pressure molding, keeping inventory waste to a minimum.

The uncured tape is supplied in rolls, 1½″ wide by 0.050″ thick . . . in lengths of approximately 320 feet . . . weighing about 16 lbs. net. When stored at temperatures not exceeding 40F, it has a shelf life of up to 6 months. Molders are invited to write for Technical Bulletin Tx-14A. Write to Johns-Manville, Box 359, New York 16, N. Y. In Canada, address Port Credit, Ont. Cable: Johnmanvil.

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# Technical Countdown

## ELECTRONICS

### Bionics Breakthrough Claimed

Sperry Gyroscope Co. scientists claim a breakthrough with their development of a bionic "brain cell," called Sceptron (Spectral Comparative Pattern Recognizer). Measuring only 1/300 cu. in., the fiber-optics assembly has a package density of 300,000 frequency channels per cu. in. Self programing, it operates in real time and in the frequency range of from 100 cps to 20 kc. The cell, Sperry says, can discriminate between different voices and even similar sounds.

### TAR Tests Successful

A light-weight terrain-avoidance radar (TAR) developed by General Dynamics/Electronics, San Diego, may find application in Army drones or aircraft. The 40-lb., ½-cu. ft. system employs an on-boresight radar with a non-scanning antenna, has a built-in analog computer and requires no radar-scope presentation for manned craft. The system has been flight-test operated for more than 150 hrs. at altitudes under 400 ft. over all types of terrain, GD/A reports.

### Super-speed Research Camera Revealed

Using a fiber-optics image-dissection camera, Bell-Telephone Laboratories reports it is capable of taking 75 X-ray photographs at a rate of 400,000 fps with good resolution. The technique is said to be ideal for recording rapidly changing phenomena. The glass fibers, imbedded in a matrix, conduct light to a photographic plate. Phosphor-coated at one end, the fibers convert X-rays to visible light. A matrix and a rapidly moving plate serve as a very-high-speed recorder. The 3-in.-sq. by 1-in. matrix contains 32,000 sheathed optical fibers held in an opaque epoxy.

### Tracker Pointing Accuracy Improved

System pointing accuracies of better that 0.1° have been achieved with a new broadband antenna feed developed by Dynatronics, Inc. This new high in accuracy, company officials said, was set in operational tests of a unique dual-conical scan feed built to track missiles and spacecraft. The unit is the first in a series of such feeds designed to fit a number of auto-tracking telemetry antenna applications requiring both broad (10 to 1) bandwidth and extreme tracking accuracy. Other units reportedly are being built for installation on Atlantic Missile Range tracking ships and at down-range stations.

## ADVANCED MATERIALS

### Rubber Insulators for Solids?

United States Rubber Co. scientists are working toward rubber-resin and rubber-fiber combinations to replace plastics as insulators in solid rocket motors. Both of these flexible materials tend to char and erode much slower than plastic components now in use. The rubber weighs less than plastics and withstands a broader temperature range.

### Aerojet Produces Tungsten Tubing

By a proprietary process, Aerojet-General Nucleonics is turning out tungsten-uranium tubing of various cross-sections in strips up to five feet long. The experimental process may simplify development of compact, high-temperature fast nuclear reactors. Tungsten tubing has been fabricated containing a 13% (by weight) dispersion of uranium oxide with a theoretical density of 99%. Pure tungsten tubes have also been made. The process is now undergoing manufacturing development aimed at advanced reactor applications.

### Thermo-Lag Evaluated for Re-entry

Under a NASA contract, Emerson Electric is evaluating its Thermo-Lag heat-blocking compounds for re-entry heat protection in advanced manned spacecraft. This is the third straight contract from the space agency to Emerson for the same general purpose. Though samples of Thermo-Lag were tested aboard the *Sigma-7 Mercury* capsule, NASA has not yet released test results on this or any of the other samples carried on the Schirra flight.

### Brooklyn Poly Builds Mach 35 Shock Tube

Preliminary tests are under way on the combustion-driven shock tube of a $300,000 Mach-35 shock tunnel being built at the Polytechnic Institute of Brooklyn. The facility, due for completion next year, will be used to study design features enabling safe re-entry of high-speed vehicles into Earth's atmosphere. Driver section combustants are hydrogen and oxygen with a helium dilutant. The bursting of a metal diaphragm generates a shock wave down the driven tube; the wave is reflected at the entrance to the expansion nozzle, resulting in high-pressure, high-temperature air.

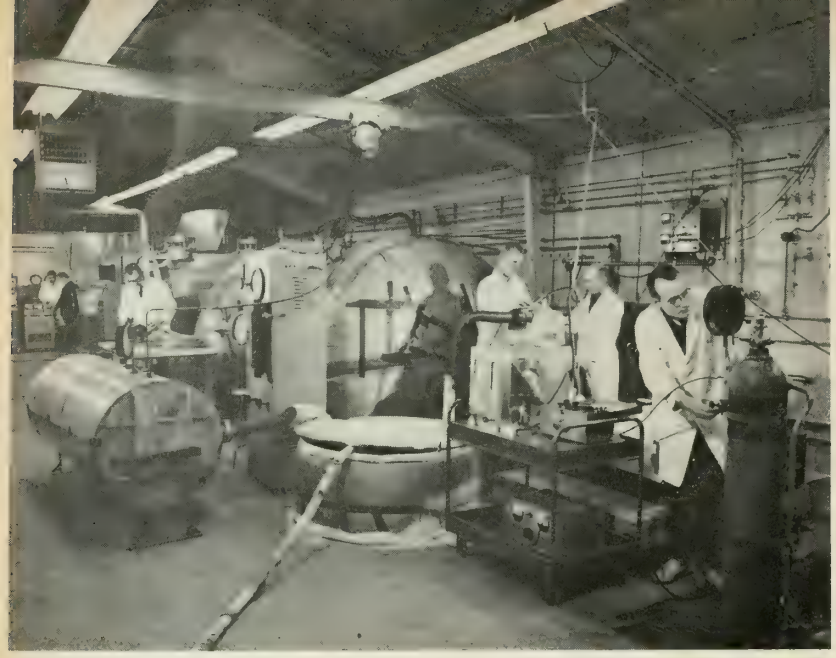
## PROPULSION

### Megawatt Space Power by 1970?

A one-megawatt space power system using turbo-nuclear conversion can be built in prototype before 1970, according to General Electric engineer M. A. Zipkin. This can be done, he says, at a specific weight of only 10 lb. kw, including 1000 lbs. of shielding—a highly favorable specific weight, compared with current estimates for *SNAP-50/SPUR* of "over" 15 lb. kw. GE has already made some preliminary components for its system, Zipkin reports.

### Interplanetary Travel by Fission Rockets

Nuclear rockets propelled by the cf flux of a gaseous-fuel reactor will outperform solid-fuel reactors by a factor of two to three, two Jet Propulsion Laboratory engineers claim. Admitting that the concept of a gaseous-fission rocket is still in the early development stage, JPL's Robert Mechreolian and Henry Stumpf maintain that for low-acceleration missions to near planets such rockets would reach their destination in substantially less time than would rockets working on an electric system.



*COMPONENTS get simulated in-flight checks in environmental labs such as this.*



*POSITIVE expulsion studies with bellows back*

## management

# Beech Widens Missile/Space Capability

BOULDER, COLO. — Beech Aircraft Corp. is moving swiftly into the missile/space market with a crucial *Apollo* systems contract and a $5-million production order for its *KD2B-1* Mach 2-plus target missile.

Long familiar for its line of light military and business aircraft, the firm is beginning to capitalize on an eight-year investment in cryogenics and allied propellant work.

It now produces airborne cryogenic and storable tanks; main and auxiliary feed and refueling systems; environmental control, attitude control and course correction systems.

Ground-support capabilities include the study, design and development of transfer and topping systems, firing stands, logistics, hydrogen support, oxygen support, storable support and environmental cooling systems.

Besides an imaginative environmental testing complex, the firm covers such related areas as advanced propellants, insulation, mass flowmeters, and partial pressure sensors in applied research.

Beech is also active in launch complex support and installation management.

• **Space determination**—Frank E. Hedrick, executive vice president, told M/R the firm is toughening up and now will go after the nonmilitary space dollar much more aggressively. In this area, Beech's effort had been largely research, with no real attempt at systems and subsystems contracts.

The *Apollo* contract represents the first major move in the nonmilitary space area. Beech will design, develop and fabricate the supercritical gas storage system, used to supply Garrett's on-board environmental control system and the $H_2$-$O_2$ to the fuel cell-electric power system.

Beech is actively bidding on other lunar-related programs, but spokesmen for the firm declined to discuss them.

There is no fixed military/commercial ratio—business has ranged all over the spectrum. Beech had $13 million in new military business in 1961; the 1962 total is around $45 million in new contracts—and still growing. This includes subcontract fabrication work on supersonic fighters and other military aircraft.

Hedrick is optimistic over Beech's chances in the tough NASA-military market because of the firm's reputation, flexibility and extremely sound financial condition. Beech is one of the rare corporations which have commercial paper, and this ability to raise cash for a program underlies all the other capabilities.

Hedrick is just as quick to point out the limitations imposed on Beech by its size and, more subtly, its ability to perform only within certain fields. Even within its scope of interests, Beech intends to go after only those jobs which are considered practical by a commercially oriented management and which are in keeping with the Beech passion for quality.

Once the decision is made to propose, the firm considers the contract already in hand—a might-as-well-give-it-to-us-now-we'll-get-it-later-anyway mode of thinking. When a bid loses out, the effort to establish the reason for the loss is as intensive as was the original competition.

Beech hydrogen experience dates back to 1954, when the Air Force funded a feasibility study into the element as a possible fuel. The then-top-secret work was moved to Boulder, Colo., in 1955, and the division has expanded steadily ever since to become



*ladder work.*



*EXPULSION unit is assembled in contamination-free area.*



*HUGE titanium $H_2$ tank built by Beech.*

## ontracts for Apollo work, supersonic target missile expand aircraft manufacturer's efforts beyond former research role

by John F. Judge

the largest commercial cryogenic installation in the U.S.

The division covers 1500 acres north of Boulder, with a manufacturing plant in nearby Longmont. The firm has an extensive environmental testing capability—both in equipment and experience. Complete space vehicle systems, components or subsystems are evaluated under conditions of vibration, altitude, radiation, acceleration and temperature extremes.

The division recently installed a huge transient heat lab, capable of handling liquid hydrogen fuel systems—including booster tanks up to 20,000-gal. capacity. Tank skins, loaded or unloaded, can be brought to 1000°F or more in an instant, duplicating the effect of aerodynamic heating.

A new test complex for use in the *Apollo* system includes a 20,000-lb.-force shaker. Other individual chambers simulate climate, radio frequency interference, high vacuum, tensile loads and explosions.

Beech engineers are subcooling liquid hydrogen—turning it to slush in an attempt to determine the feasibility of further reducing fuel volumes. The approach would increase the fuel load of a given tank without a corresponding increase in tank size.

Propulsion system studies are under way for the *Centaur* program. Beech is exploring space-rendezvous refueling methods and hydrogen supplies for nuclear rockets.

The firm has tested thousands of items in the *Titan I* program, designed and built the fuel transport trailers for the *Titan II* and delivered 76 topping units for the *Atlas* ICBM.

In another instance, Beech built the largest titanium assembly in the country for hydrogen tankage testing. The vessel, 8 ft. across and 24 ft. long, is the smallest size that will yield design data required for a theoretical production tank measuring 30 ft. in diameter and 120 ft. long.

• **Weightless fuel**—The main effort in positive expulsion systems for zero-G environments centers in bladders—flexible bags tailored to fit inside a rigidized container. Positive expulsion is achieved by pressurizing outside of the bag if it contains the propellant, or inside if it is collapsed within a tank loaded with propellant.

Basic bladder design can be either hemispherical or spherical. The former

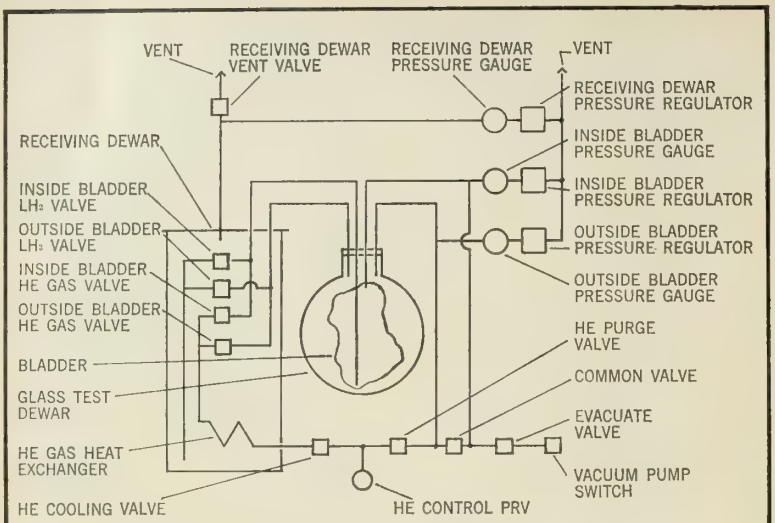
• Tensile and tear strength—Analysis attached to the equatorial periphery of the tank, and lies against the inner contour, to permit full loading of the tank. The spherical approach involved a fully collapsible bladder which fits the entire tank in the expanded condition.

The first approach carried a weight penalty in the fittings around the circumference of a tank and posed a difficult sealing problem. The second method necessitates only a small neck fitting and cover plate—sharply reducing the weight and sealing aspects.

The major problem with the fully collapsing unit is its susceptibility to random wrinkling and folding over most of its surface. The resultant three-corner folding increases material fatigue, creates pin-holes and eventual membrane failure.

Beech experts took the fully-collapsible bag route which, in turn, forced them into a major materials evaluation program. A series of test objectives was set up and included:

• Flexibility at low temperatures—The main requirement of any bladder material is its ability to stand folding at −423°F. Failing this, a material is simply eliminated.




*BLADDER TEST APPARATUS—After purging the system, Beech engineers can run either inside or outside expulsion tests on bladder materials. The schematic resembles the remote control board in function. The receiving dewar acts as a liquid hydrogen supplier and then handles the expelled fuel. The system is designed to permit pressurization of the bladder during the filling cycles, preventing a large pressure differential which might rupture the test bladder in a test apparatus failure rather than through expulsion cycling.*

• Tensile and tear strength—Analyses show no pressure differential across a bladder under ideal operating conditions, but tensile and tear strength considerations must be taken into account. This covers any pressure differential which may occur—whether due to time lag or operating conditions.

• Permeability — Prevention of propellant-pressurization mixing and mission profiles determine permeability limits, but the trend is toward the lowest possible permeability.

• Fabrication—The material must be readily adaptable to existing techniques and procedures.

Other factors include density, thermal conductivity, cryogenic compatibility, impact sensitivity with LOX, and radiation effects.

Beech has had its best results with Mylar bladders supplied by the G. T. Schjedahl Co., Northfield, Minn., although the firm has fabricated all the test bladders to date regardless of material.

The bladders are, in effect, three concentric bags with a common opening. The three-ply approach increases both the strength and reliability factors. Tests have been successful even though the inner and outer plies were perforated.

Triple membranes of ¼ to ½-mil Type A Mylar have been found capable of withstanding the flexing and folding required to expel liquid hydrogen, LOX and liquid nitrogen. While the optimum number of individual membranes has not been fully established, the three-ply method is feasible for liquid hydrogen missions.

The prime failure area is near the neck flange—where the bladder material extrudes into small crevices in the assembly. Redesigning the flange avoids this.

All testing was confined to spherical tanks, but no problems are foreseen with other tank configurations as long as the internal finish of the vessel is good.

• **Low-acceleration area**—Beech is also exploring fuel flow and allied space storage problems for electrical engines. The electrical propulsion work is a general study area encompassing materials selection, metering and flow control, weight and size breakdown and problems associated with the zero-G environment.

Revised thinking characterizes the Beech approach to long-term, cryogenic space storage. For one specific application, a composite insulation system with both load-bearing and non-load-bearing capabilities is being perfected. Retractable supports sustain an outer insulation shell through launch-imposed loads. In deep space, the supports retract, leaving the outer insulation gently supported by springs and eliminating the heat path supplied by the supports.

In the zero-G feed area, some Beech researchers doubt the surface-force approach will be totally effective in low-acceleration systems. Even if the methods work out, their application is far in the future and will involve extensive zero-G testing.

Some of the alternate ideas include bootstrapping and even jelling the propellant. Beech has jelled cryogenic liquids such as nitrogen, ammonia and hydrogen. In one instance, a hunk of jelled nitrogen was thrown on hot concrete and its resultant behavior was very similar to that of dry ice.

Jelling has some intriguing advantages in space propellant handling. The jelling agent might contribute to temperature control—at least it cuts down the normal convection. While the thinking is currently directed toward electrical engine fuel problems, large chemical vehicle aspects have been included. Jelling would avoid super-critical pressurization problems and might simplify downstream regulation. Handling would also be easier although tanks would probably have to be pre-cooled before loading.

No attempt has been made to jell LOX, but Beech researchers feel confident here. Enough jelling agents are available. The agent itself can be filtered out just before introduction to the firing chamber—easily handled in small systems, but filter clogging becomes a factor as the propulsion system grows.

Jelling concepts are not being actively pursued with any definite system in mind, but the area does represent the kind of novel approaches considered by Beech.

Beech Aircraft is commencing initial prodution of the supersonic target missile, *KD2B-1* under a $5-million contract let by the Navy's Bureau of Weapons. An additional $10 million is expected before the end of 1962 on the program. The production will be carried out at the Wichita plants.

The target missile is completely Beech-designed, including the guidance. Powered by Rocketdyne's LR-64-NA-4 storable-fueled engine, the 560-lb. target is capable of speeds up to Mach 2-plus and altitudes of 70,000 ft.

The expendable missile is adaptable to the Navy's F-3 and F-4, the Grumman F-11, North American's F-1, and the Douglas A-4 and F-6 aircraft. The *KD2B-1* also fits the Air Force's F-101, F-110, F-102, F-106 and the B-57E. It can also be ground launched from a Beech-designed mobile launcher and it is designed for shipboard operation.

The target's speed and altitude capabilities make it the only system capable of matching the latest jet aircraft of any potential aggressor.

Beech engineers consider the target missile more sophisticated in many ways than some weapons systems and the *KD2B-1* could easily be re-designed as such. The same configuration could reach altitudes up to 90,000 ft. and speeds in excess of Mach. 3.5. ⁂

# Weightlessness Still Worries Soviets

***Concern voiced over effects of prolonged flight on blood production, tissue regeneration***

**by Heather M. David**

NEITHER of the latest Soviet spacemen suffered from "Titov's sickness" in the recent orbital flights, but the Soviets still fear that prolonged weightlessness may produce harmful effects.

Dr. Eugene Konecci, chairman of the International Aeronautical Federation Bioastronautics Committee, told M/R about these Red reservations, expressed during the recent committee meeting at Varna, Bulgaria.

Dr. Konecci said the Soviets programed a number of violent head maneuvers in their recent flights to see whether this caused the nausea Titov suffered. However, neither cosmonaut became ill.

The Soviets had conducted some training to avoid this illness. A number of rotating and tumbling devices were employed to accustom the cosmonauts to these movements.

The U. S. delegate said that Titov possibly had some individual peculiarity which caused his sickness. He also said it might have been caused by random tumbling of *Vostok II*, or that *Vostok II's* stabilization system was compensating.

• **Lab-type experiments** — During the dual flights Major Andrian Nikolayev was chosen as the subject of medical research, and Lt. Col. Pavel Popovich was the control. Soviet biomedical measurements included electrocardiograms, respiratory rate, pulse, body temperature, galvanic skin reflex (ankles), nystagmus, and electroencephalogram.

Nikolayev wore a little scull cap under his leather helmet to which surface electrodes apparently were attached. The nystagmus experiment, or measurement of the eye movements, was conducted with an electrode over the corner of his eye. Eye rolling is associated with nausea and vestibular illness, but apparently none occurred.

Soviet academician V. I. Yazdovsky told the meeting that he was concerned with the problem of a space pilot's return to Earth after prolonged flight. Although no pathological changes appeared during the recent two flights, he stated that "the biological action of zero gravity on more delicate processes in cellular and subcellular structures, blood production and tissue regeneration and many other intimate processes, is not clear." He added that clinical investigations had caused some apprehension.

The two recent flights differed little from earlier Soviet flights in physiological reaction. Heart rate during boost was 120 pulses per minute for Nikolayev and 130 for Popovich. Respirations were 10 and 20 per minute respectively.

As they went into orbit, Nikolayev's heart rate was 100 per minute, Popovich's 90, and respiration 10 and 16. By the sixth orbit, heart and respiration rates returned to "values recorded several hours before the beginning of their flight."

Average pulse rate for the four-day Nikolayev flight and three-day Popovich trip was about 60 to 70 per minute; respiration was 10-15.

Yazdovsky indicated that the Soviets are pursuing their research in three main lines:

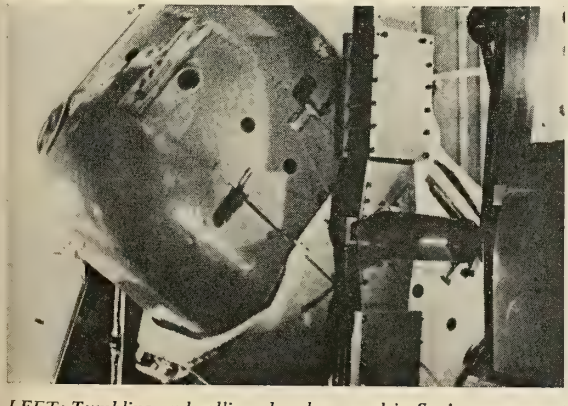
—Influence of factors of outer space on living organisms and man.

—Biological and medical foundations of providing conditions necessary for life throughout space flights.

—Investigation of forms and conditions of extraterrestrial life.

However, he said that at present the most pressing problem is "development of the principled foundations of providing conditions necessary for life and security of a cosmonaut in space flight."

• **Vostok configuration**—Dr. Konecci said present information indicates that although the *Vostok*-type vehicle is a one-man system, it apparently can be enlarged for multicrew operations by adding a constant section behind the cosmonaut. This way it could be made into a two or three-man tandem, such as that employed on our B-58. He said it appeared that two *Vostoks* could be modified for rendezvous by the construction of a hatch, forming a space station. ⁂





*LEFT: Tumbling and rolling chambers used in Soviet cosmonaut training to accustom the spacemen to maneuvers which might have caused Titov's apparent vestibular illness. RIGHT: Note white electrode next to pilot's right eye to measure nystagmus, or eye movements associated with nausea and motion sickness.*

# Project Orion Decision Imminent

***Air Force has no requirement for bomb-powered 1000-ton payload system; development could shift to AEC/NASA***

**by Frank G. McGuire**

DECISION ON Project *Orion*—the nuclear-bomb-powered rocket—as a Department of Defense development program appears imminent. *Orion*, a four-year-old research program funded at about $2-million annually, has been a virtually forgotten attempt to develop a space vehicle with a 1000-ton payload.

Despite high-level enthusiasm for the project and numerous indications that the vehicle would have tremendous potential, Air Force appears to be having trouble justifying continued support of the program.

• **Policy decision**—Conflicting statements by congressional, Air Force, and DOD spokesmen leave a question mark hovering about the *Orion* decision, and speculation is that matters of policy, not feasibility, will play the key role in its fate.

"Air Force is even having trouble justifying a two-ton *Gemini* space capsule, let alone a space vehicle with a 1000-ton payload capability, and it's very difficult for us to see where it fits in," said a Defense Department spokesman in explaining the Pentagon viewpoint.

An Air Force officer commented, however, that translation of this remark into a cancellation of *Orion* "would not be a very safe assumption."

The DOD decision is reportedly in the hands of Dr. Harold Brown, Director of Defense Research and Engineering.

*Orion* had been given an encouraging boost by Dr. Jerome Wiesner in the ad hoc committee report to President Kennedy which stated: "Above all, we must encourage entirely new ideas which might lead to real breakthroughs. One such idea is the *Orion* proposal . . . This proposal should receive careful study with a realization of the international problems associated with such a venture."

Informed sources indicated that the present decision is a move in the Air Force's battle over participation in space flight activities in furtherance of its military mission. With the large payload of *Orion*, its relatively low operating cost, and its far-ranging operational ability, Air Force is eyeing it as a major vehicle in the mid-1970 time period.

Born at Los Alamos Scientific Laboratory in 1955, *Orion* was conceived by Dr. Stanislaw M. Ulam, who feels the vehicle could be flying within five years if pressed on a national scale.

Air Force Special Weapons Center, monitoring the program for AF Systems Command, has conducted applied research on the program with the prime contractor, General Atomic, since July, 1958.

• **Air Force thwarted**—The effort to keep AF out of intensive space hardware development has shown through on phases of the *Orion* program.

"We tried to have a reasonable development schedule worked up and used as a DOD guideline," one source remarked, "but since it would have included flight dates and required a stated mission, we were told to forget it and continue working at our present pace on our present budget. We were also denied permission to set up some experiments at the current Operation Dominic nuclear weapons tests in the Pacific."

It has been known that applied research on structures and materials in the program have been encouraging in pointing up the feasibility of the concept, but development problems still remain.

Congressional attitude, voiced by the Joint Committee on Atomic Energy, is that development of the low-risk, high-payoff project should continue despite lack of a clear-cut military need.

"In general, severely curtailed important nuclear programs should be handled by the Atomic Energy Commission if the Defense Department cannot prove a need," a JCAE spokesman said, but declined to comment specifically on *Orion* until the DOD decision becomes known. Other sources on Capitol Hill told MISSILES AND ROCKETS the *Orion* program "is in real trouble."

The JCAE source pointed out that Project Rover was in essentially the same straits early in its development cycle, and was kept alive by non-DOD funds after USAF dropped the program in 1960—the inference being that *Orion* could follow the same route to becoming a major space program.

• **Holifield hints review**—If the Pentagon decides to drop the program, Rep. Chet Holifield (D-Calif.), JCAE chairman, said he plans to ask for a full technical report on which to base committee recommendations.

If past JCAE policy prevails, *Orion* could land in the joint AEC/NASA Space Nuclear Propulsion Office. SNPO Manager Harold B. Finger told M/R his office has not yet had a close look at *Orion* in connection with the current re-evaluation, but that he is interested in the potential, development problems and funding of the program.

International repercussions of the *Orion* approach would depend primarily on whether the vehicle was used from the Earth's surface or merely as a ferry between planetary orbits. Fallout from the small-yield nuclear charges has been described as "quite small," but even this fallout would provoke criticism.

Project Put Put, a proof-of-the-pudding test, has been carried out using a 3-ft.-diameter, 300-lb. scale model and 3-lb. high-explosive charges to check out *Orion's* feasibility, but nuclear charges have not yet been used.

• **How it works**—In a nutshell, *Orion* works like this: small nuclear bombs of about 0.01 kiloton yield are dropped from the rear of the vehicle at one to 10-second intervals and detonated at a distance of 100 to 1000 ft. Both the drop rate and detonation distance depend on the acceleration required and the vehicle design.

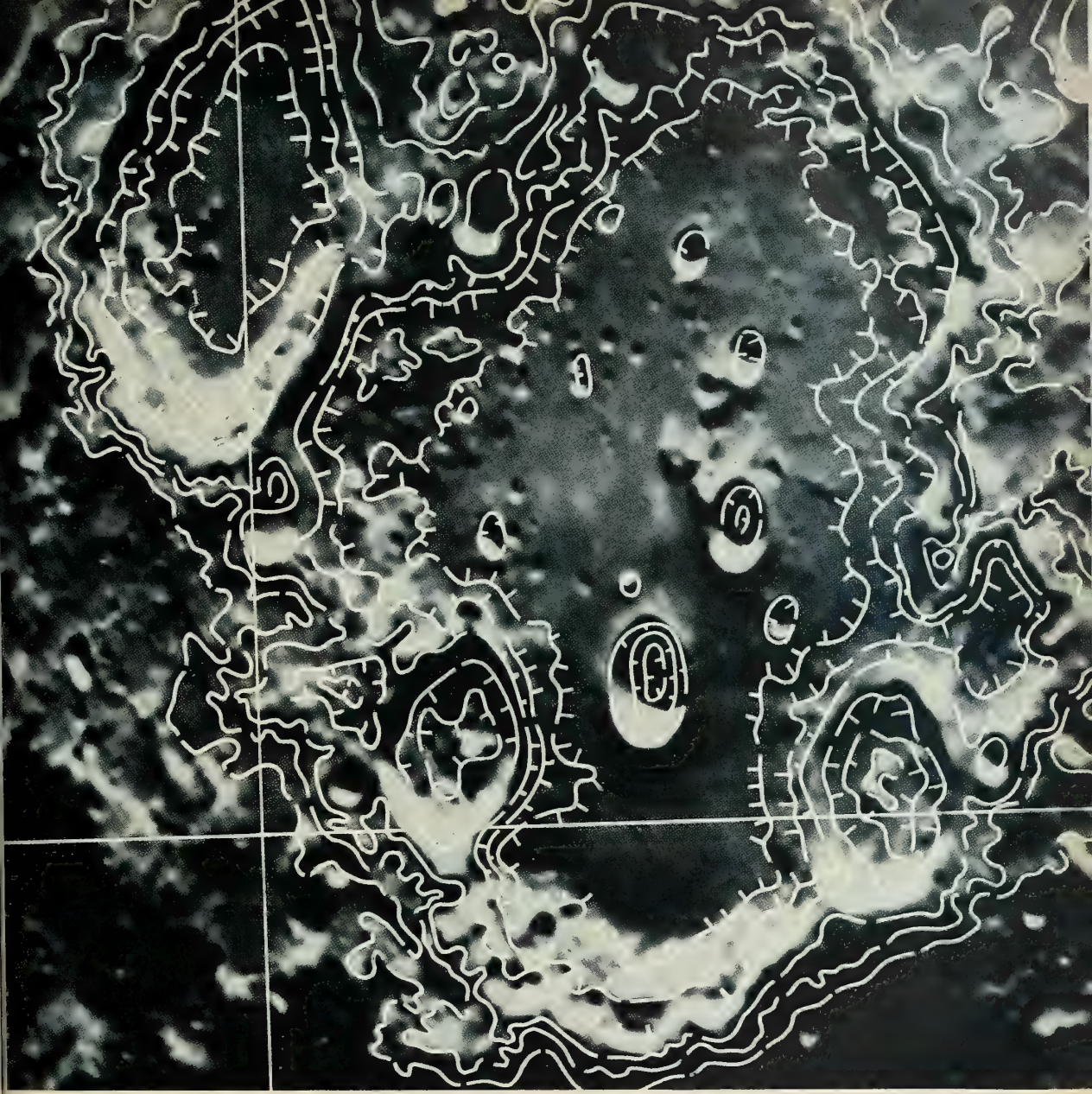
The propellant-loaded bomb imparts energy to a pusher plate at the rear of the vehicle. The plastic or other low-molecular-weight propellant works on the ablative pusher plate with as much as 100,000 seconds specific impulse equivalent.

The ablative nature of the pusher plate, as well as its structural design, serves to absorb both impact and thermal shocks generated by the bombs.

*(Continued on page 34)*



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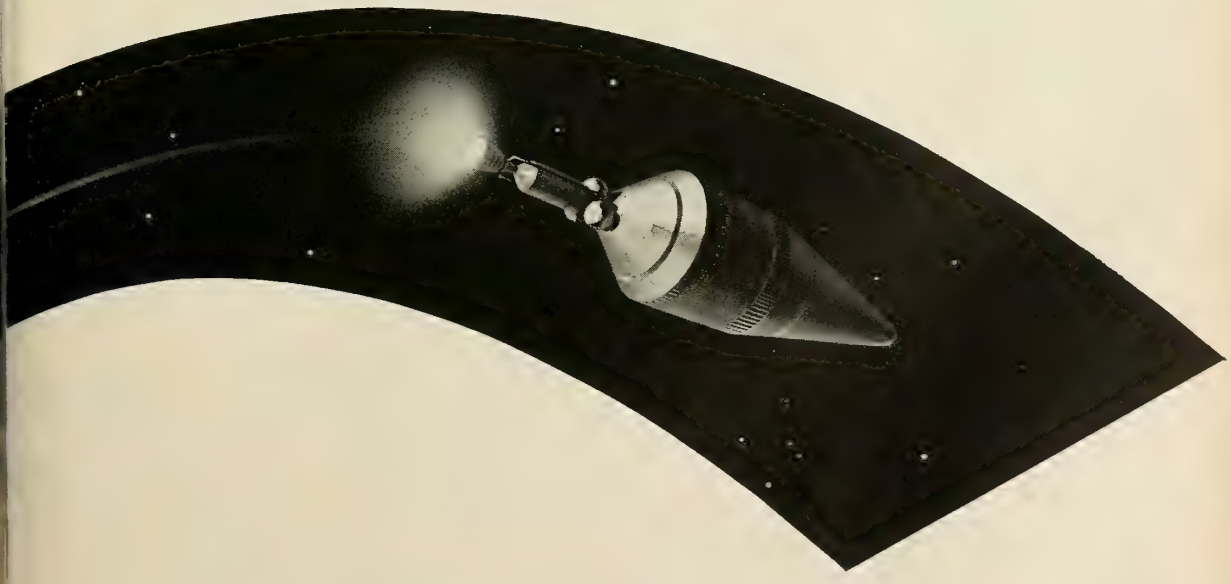
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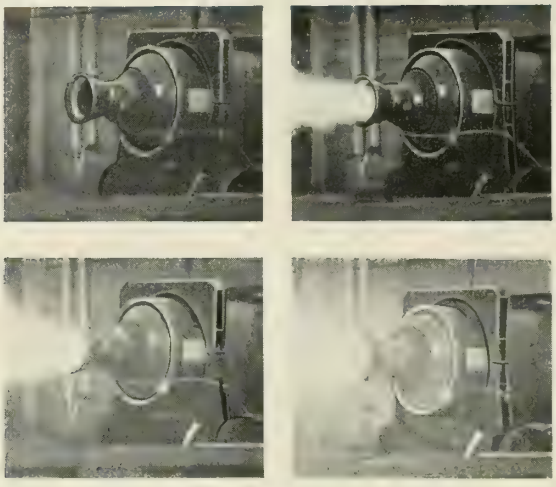
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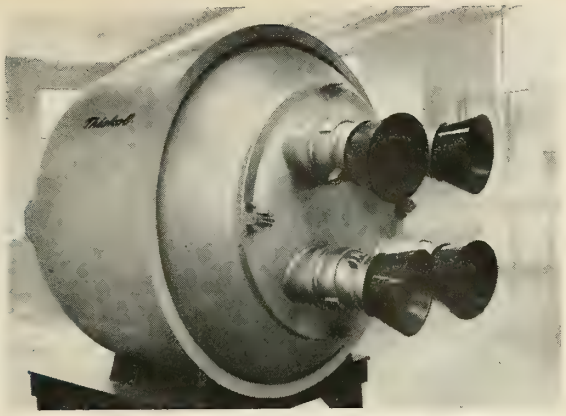
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## Project Orion

*(Continued from page 28)*

Because of the extremely short duration of the individual nuclear pulses, the effective exhaust velocity corresponds to that of very-high-temperature systems, according to General Atomic, and the removal of this temperature limitation is what makes specific impulses of as much as 100,000 seconds conceivable.

Acceleration of the vehicle would be between two and nine G's, which is transmitted to the main body of the rocket through the spring-mounted pusher plate.

The gross weight of *Orion* could easily be on the order of eight million pounds. Although a family of different sized vehicles has been designed, general characteristics for a typical lunar-mission booster are:

- Structure weight: 3.5 million lbs.
- Expellent weight: 1.75 million lbs.
- Plutonium needed for Earth orbit: 300 kilograms.
- Plutonium needed for soft lunar landing: 525 kilograms (About 800 bombs).
- Payload on the moon: 1.5 million lbs.
- Cost per lb. of structure $3.85.
- Cost per lb. of plutonium: $30.00.
- Cost per lb. of payload on the moon: $29.60.
- Total cost of mission: $13.3 million.

As in any other such program, the figures for *Orion* at this stage of development are highly speculative and dependent on numerous engineering considerations.

• **Propulsion breakdown** — The physics of *Orion* are rather straightforward in that the first effect of the bomb is a wave of electromagnetic energy travelling at the speed of light and striking the vehicle in an intense burst. The impact gives a forward thrust to the rocket. The ablative pusher plate loses a thin layer of material in vaporized form, and this vapor is exhausted to the rear, also giving impulse.

A second effect, that of the wave of physical particles which originally constituted the bomb, gives further impulse forward by their impact on the pusher plate. These high-velocity particles, closely following the initial electromagnetic wave of energy, gradually erode the pusher plate through numerous collisions.

Problems involved in the *Orion* concept include wasting of unfissioned material and the spread of radioactive waste products, as well as design difficulties brought about by the nature of the system.






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If the individual sharp impulses from the nuclear detonations are not completely controlled, severe damage to the vehicle and payload would likely result, even if the average accelerations were small. Attempts to flatten out the acceleration pulses over a period of time have resulted in the spring-mounted plate approach.

Dr. Ulam has suggested that possible development of "shaped" nuclear charges would solve the problem of wasted energy from each detonation. It could also present guidance difficulties if the focal point of each explosion relative to the vehicle were not constant or at least within tolerable limits.

The heat generated by the bomb, although extremely high at the core, is not of serious danger to the vehicle because of the insulation protection offered by the intervening space.

Development of *Orion* is currently being monitored by Col. Frederick Gross, AFSWC, Physics Division. At General Atomic's John Jay Hopkins Laboratory in San Diego, *Orion* work is under Dr. John M. Wild, director, with design engineering headed by Dr. David J. Peery. General Atomic currently has about 25 scientists working on *Orion,* a number of whom were formerly with Los Alamos.

• **Costs** — Total development costs for an operational *Orion* vehicle have been estimated at $1.5-billion. General Atomic's first contract in 1958 was for $2.5-million to cover essentially the first two years of work. Fiscal 1962 contract was for $1.7-million.

In a similar vein, Martin Marietta Corp. has proposed a bomb-powered rocket which would use 0.01-kiloton-yield bombs to propel a 3.5-million-lb. vehicle at velocity gains of 26,000 fps. The Martin vehicle uses a spherical chamber rather than a pusher plate to transfer energy to the vehicle, and specific impulse is about 1150 seconds. This is probably the approximate figure of *Orion's* specific impulse also, since the quoted figure of 100,000 seconds was the conceivable ultimate.

Martin's proposal uses a water expellant injected into the spherical chamber and exhausted at detonation of the bomb to obtain thrust. Wall thickness of the 130-ft.-diameter spherical chamber would be only 0.5 inches.

Payload weight of the Martin vehicle would be 350,000 lbs., carried in a 300-ft.-long vehicle designed to expel 858 lbs. of water with each nuclear explosion. The one-second-apart explosions would total 2400 bombs in one version, and 5800 bombs in two other larger versions. Average thrusts of the smallest rocket would be eight million lbs., while the bomb cost is estimated at between $10,000 and $40,000 each. ⌘

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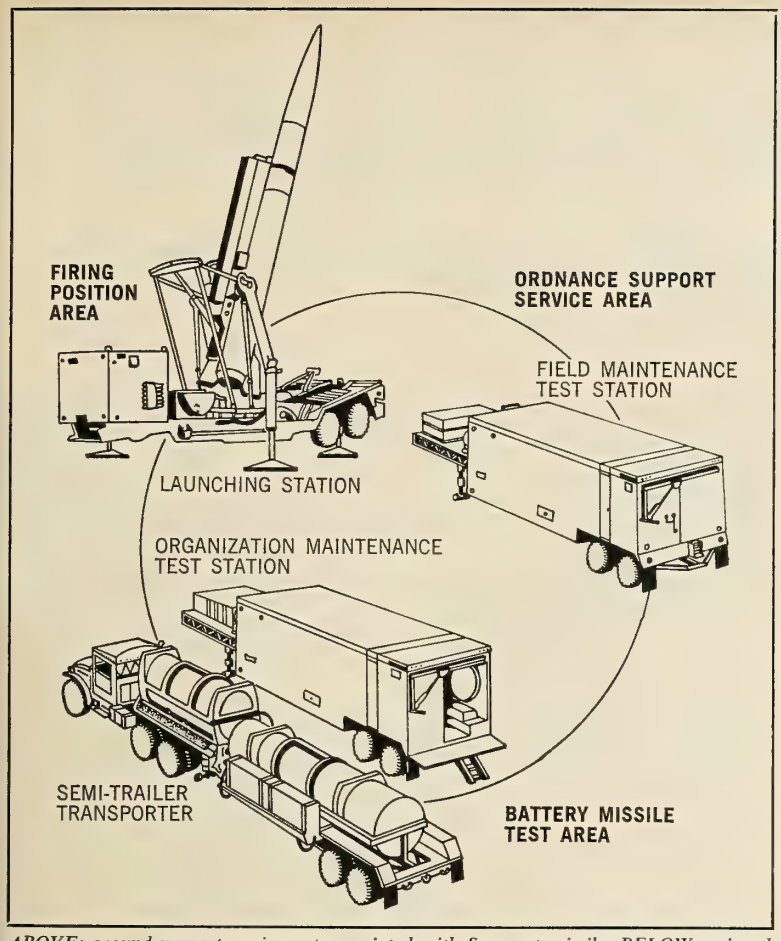
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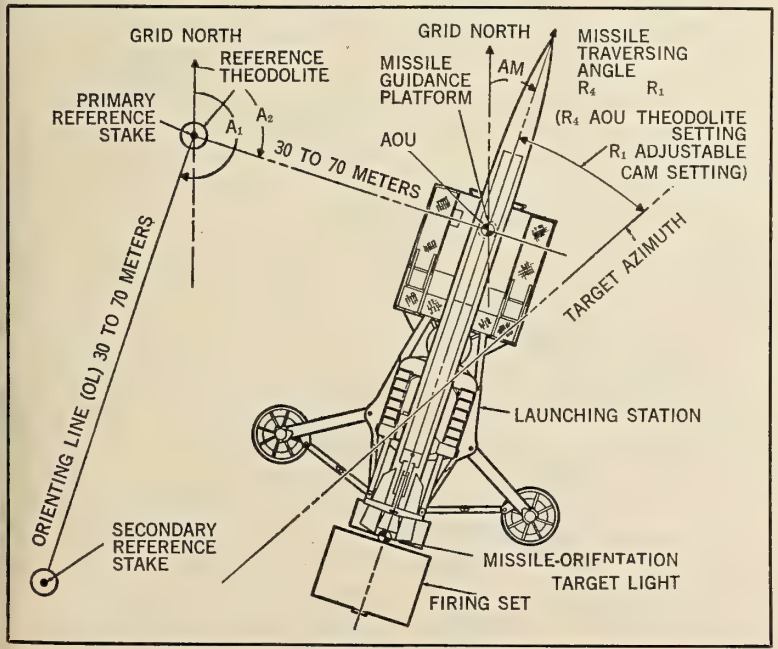
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*ABOVE: ground-support equipment associated with Sergeant missile. BELOW: azimuth orientation diagram indicates procedures required for modified reciprocal laying method used to align missile guidance platform. Missile is finally raised to 75° firing position.*




## Sergeant Success

*(Continued from page 17)*

to the battery. The OMTS can be used in checking out and replacing major assemblies, such as the guidance section or fins, and also employs complete self-check. Checkout is fully automatic, providing a go or no-go output. It isolates malfunctions to the electronic assembly level only.

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• **The Countdown**—All fire-control operations are automatic after the target and firing data are inserted by the operator at the firing set control panel. The countdown, from the time the missile is assembled, requires 44 minutes. Sequence is approximately as follows:

*T—44:* firing set energized for pre-heat, firing box tested and emplaced, transfer switches turned to "self test."

*T—39:* power on, self test begun, firing data parameters inserted and computed.

*T—35:* self test complete, fire mission computed and checked.

*T—30:* required parameters readout and program cleared.

(Before *T—30*, a hold can be called at any time and maintained indefinitely; at *T—20*, battery can hold for several days.)

*T—20:* begin automatic countdown and start program.

*T—19:* insert first block of parameters.

*T—12½:* insert and check random readings.

*T—7½:* insert second block of parameters.

*T—3½:* check flight parameter computations.

*T—3:* assume remote firing control.

*T—0:* missile fires automatically, barring operator override.

Automatic holds dictated by sensing circuits stop the launch programer and require resetting to *T—20*. Command holds can be called at any time and require resetting based on the following limits:

*T—7½:* hold for variable time depending on motor temperature and other sensitive subsystems.

*T—90 sec.:* hold for 10 minutes.

*T—20* to *T—0 sec.:* hold for 2 minutes.

Time on target is approximately the countdown sequence time plus 90 sec. ⌗

# Block Circuits Promise Reliability

***Significant gains predicted in discussion of conventional vs. microelectronic packaging***

**by Michael Getler**

HOBOKEN, N.J.—Within a few years, refinement of functional block circuits should yield significant gains in electronic reliability.

A reliability comparison between microelectronic circuit packages and conventional designs, delivered at the Institute of Radio Engineers' annual Electronic Reliability Conference here recently, showed that both types of packaging would continue to be needed for particular applications. But it pointed strongly to the improvements to come with development of functional block, or molecular electronic, circuitry.

The comparison, made by Joseph P. Morone, Jr., a reliability supervisor with P. R. Mallory & Co., Inc., of Indianapolis, covered these broad categories: wired circuits, printed circuits, cordwood packaging, disciplined geometry assemblies, "pellet" or "dot" type assemblies, thin films, solid silicon circuits, and functional blocks.

Key factors in the comparative reliability discussion included number of separate electronic components; number, type and length of interconnections; design and construction simplicity; mechanical, thermal and climatic adequacy; maintenance and repair; and general circuit considerations.

• **Number of components** — Functional blocks, Morone says, represent the ultimate in reliability from the numbers point of view, although it may be several years before their potential is fully realized. Current thin-film and solid-silicon technology also provide good capabilities. But until these techniques are applied to more of the circuitry now in demand, heavy reliance still must be placed on discrete component approaches.

• **Interconnections** — Full exploitation of functional block technology will also yield highest reliability in terms of the number of electronic part interconnections. Thin-film approaches, the author says, provide the next level of reliability.

However, he noted, at this point not all electrical elements can be produced by thin-film techniques; furthermore, joining two dissimilar films poses connection problems. Cordwood, micromodule, and pellet packaging systems are said to represent the next level of reliability.

The biggest reliability problem present today, Morone asserts, is in the type of interconnection. Neither soldering, welding, thermocompression bonding, vacuum deposition, cementing, or any other technique has proved to be superior across the board. Judgments here must be based on the materials to be joined, sensitivity of the parts, control of joining parameters, and post-joining environment. Strict quality control is essential.

None of the various packaging concepts, he reports, appears to have any inherent reliability advantage in connections between electronic packages, all of them using similar type ohmic contacts for signal communication.

• **Design and construction simplicity** —Both conventional and advanced techniques are running into problems. Uniformity in component size and shape will aid considerably. Conventional systems suffer most from this disparity at present.

However, production methods and efficiency are also sacrificed when solid-state and thin-film approaches are used, as more and more parts are formed and deposited on a single substrate. It is necessary to locate the economical and reliable cut-off point in this process.

• **Mechanical adequacy** — Virtually all types of packages can be made to withstand most shock, vibration, and acceleration extremes. But the author notes that microminiaturization eases the problem a great deal by virtue of the low masses and correspondingly low structural stresses associated with these techniques. In addition, these low masses are generally associated with higher resonant frequencies.

Morone rates the mechanical adequacy of circuits in the same order as packaging densities: functional blocks finish first, printed and wired circuits last.

• **Thermal**—Lower heat concentrations and larger heat dissipation surfaces favor conventional packaging. Advances in cooling microelectronic packages, while needed particularly for aerospace applications, have not developed as quickly as many observers would like.

Morone asserts that the most effective cooling method with compact equipment, at this point, uses conductive techniques at the components part level—with convection, forced air cooling, and other methods ultimately used to transfer heat to the sink.

Use of flat plate thermal conductors between subassemblies in a disciplined geometry assembly, so that all components are in touch with the conductor, offers significant advantages.

• **Climatic**—Morone claims no particular system appears to have any significant inherent advantage with respect to reliability.

• **Maintenance**—A careful analysis is required in selection of either conventional or miniaturized packaging scheme. Factors to be studied include: expected meantime-between-failures, expected repair time, ease of locating and repairing faults, parts costs vs. module costs, and expected reliability of repaired equipment.

• **Circuit considerations** — Advocates of microelectric packaging, according to Morone, admit greater electrical capabilities with conventional techniques, but assert that within their own capabilities their circuit reliabilities are equivalent to conventional designs.

Major aggravations with microcircuits are attributable to the small size and close spacing—these create a variety of undesirable electrical interactions.

Intercircuit leakage problems are often posed by short continuous paths between circuits completely surrounded by a potting compound. Microcircuits also require improvements in voltage and current capabilities. ⁂

# Litton Turns Its Sights Toward Space

## *Highly diversified and rapidly expanding company saves vital time by buying existing capabilities*

**by Willard E. Wilks**

BEVERLY HILLS, CALIF.—Litton Industries has opened a major drive for more space program business.

Until recently the firm has concentrated on inertial navigation systems for manned aircraft and other areas where there has been greater product demand. "Now we are turning more attention to space utilization of our products and technologies," George T. Scharffenberger, executive vice president of Litton Systems told MISSILES AND ROCKETS.

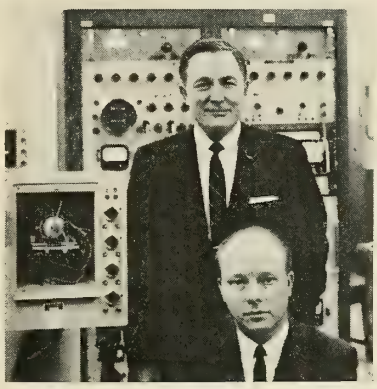
Litton Systems has components in many missiles, but it regards this business as "peanuts" compared to the sales dollars it has logged as the world's leading producer of military inertial navigation systems. Nevertheless, it believes some of its 2000 products can be turned into profitable space vehicle hardware. "It is possible, for example, that one of our intertial navigation systems can be taken as a unit and put in a lunar logistics vehicle," an executive said. Emphasis is on attracting more space dollars by stressing efficiency and economy possible with use of the existing products and capabilities that Litton has built into a $500-million-a-year business in less than 10 years.

But Litton also is coming up with some new items, including a flight data system that marks the firm's "significant" entry into the manned space field. Litton expects this system, being developed under a classified contract, to give it a position in the space systems market comparable to that which it now enjoys in the aircraft inertial guidance field.

The company is also developing a "moon suit," unique in that it resembles a flexible deep sea diving suit with bellows-type joints allowing the wearer greater freedom of movement than does a pressure suit or a rigid capsule-type suit.

In addition, the firm now is offering an electric propulsion system, utilizing a linear plasma accelerator, and has four prime contracts in plasma physics research.

• **Broad spread**—New emphasis on the space hardware business does not indicate less effort anywhere else, according to President Roy L. Ash. "We are pushing on all fronts," he says.



*LITTON BOARD Chairman Charles B. Thornton (standing) and President Roy L. Ash, credit "expanding integration" with helping vast sales growth.*

"All fronts" includes everything from producing S&H Green Stamps to building nuclear submarines—as well as continued search for new acquisitions, currently in the business machine and industrial instrumentation fields. It now has 61 plants and laboratories in 15 states and nine foreign countries.

Litton's broad product spread, coupled with its many acquisitions—34 to date—has seemed like wild diversification to many Wall Street analysts. Litton executives have spent a great deal of time explaining Litton to the financial community.

After conferences with top Litton management, one New York analyst wrote back: "As you are no doubt aware, considerable doubt has arisen in the minds of investors and security analysts concerning the philosophy of Litton's acquisition program, and the company's ability to grow at a rate commensurate with the past. You have done much to dispel this feeling in my mind."

Board Chairman Charles B. Thornton says that, though Litton constantly seeks new fields and usually has an acquisition deal in some stage of negotiation, it doesn't diversify for diversification's sake alone. "In the business we're in," Thornton says, "there is plenty of room for diversification." And a Thornton admonition repeated around the the company is: "Don't attach useless udders to the corporate cow."

• **50-50 split**—While Litton's product spread seems to some defense industry observers to border on the fantastic, Thornton and Ash insist all Litton activities and products stem "from a body of common technologies."

Ash points out that no one Litton program comprises more than 10% of sales, and no one product line "do we project as accounting for more than 20%." He estimates the following sales breakdown for Litton's five operating divisions: electronic systems (defense), 30-35%; electronic components, 9-12%; business machines, equipment and supplies, 30-35%; commercial electronic equipment and services, 9-12%; nuclear submarines and other vessels, the rest.

Defense-commercial split is about 50-50. In addition to inertial navigation systems for military aircraft, Litton defense products include such missile/space items as tactical data systems, flight control systems, shipboard navigation systems, guidance and control computers, antennas, air data computers and components.

Thornton and Ash consider "expanding integration" to be a key part of the formula that has multiplied Litton sales nearly 170 times since its beginning as a tiny microwave outfit in 1953. A prime defense field example of this is Ingalls Shipbuilding Corp.—builder of nuclear submarines and surface vessels, and Litton's largest acquisition to date.

"What happened in the aircraft industry after World War II probably will happen in shipbuilding," Thornton said. "Building the hull is nothing. The submarine is the most complicated electronic package today."

Since acquiring Ingalls less than a year ago, Litton has started long-term developments it believes will result in "the biggest step to date toward bringing Litton's various technologies to bear on the military market." According to

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Ash, there is an "inevitable" trend toward greater automatic operation in ships and submarines: "Look at the amount of equipment a submarine needs —detection, attack, navigation, control, communications, weaponry. The Navy has seen the advantage of more completely integrating weapons systems. There will be greater integration of jobs into computing capabilities."

Thus the firm expands by integrating shipbuilding into its organization through the same technologies and products it uses in aircraft, missiles and business machines.

Thornton admits he has been "disturbed" that Litton's policy of growth by acquisition has aroused fears among its investors that the firm is building a house of cards. He and other executives point to one factor—time—in explaining Litton's acquisition philosophy.

• **Buying time**—"In today's fast-moving technology, there's no time to develop all of our own capabilities, so we acquire them. We've bought people, products, brand names, buildings and sales forces—all adding up to time."

In some cases acquisition of "time" involves buying a market position. "Many companies think ability in the laboratory is the way to success," Ash says. "We think a market position is equally important. And we know our marketing in the same degree of gory detail that we know our technologies."

Part of the advantage in "owning" a market, Ash says, is that "you can watch the upstarts. If they come up with something good, you can rush back to the lab and beat them. Or you can save your money and watch them go down."

As for future Litton directions and acquisitions, Ash reports, "We are setting no arbitrary limit on the technologies that will join our pool, nor the markets we will seek." The firm has a full-time staff working on an enormous traffic of acquisition proposals. Brokers call with offers, and tips are likely to be received by almost anyone at Litton, from the top down. Most unsolicited proposals are rejected quickly because "they don't tie in." Savings and loan outfits are an example.

"People become confused, of course, regarding our mergers," Thornton says. "One thing that handicaps us a little bit is that the stockholders are confused about our planning. They don't see the entire plan because if you reveal the whole plan you tell your competitors."

While Thornton is reluctant to reveal much about Litton's "master plan," he makes it clear what it is *not:* "Some people can't visualize a plan unless they see a long, detailed forecast—hell, that's not a plan, it's a budget. You can lose the forest for the trees. With a very detailed long-range plan, you also begin to lose some of your flexibility. Our



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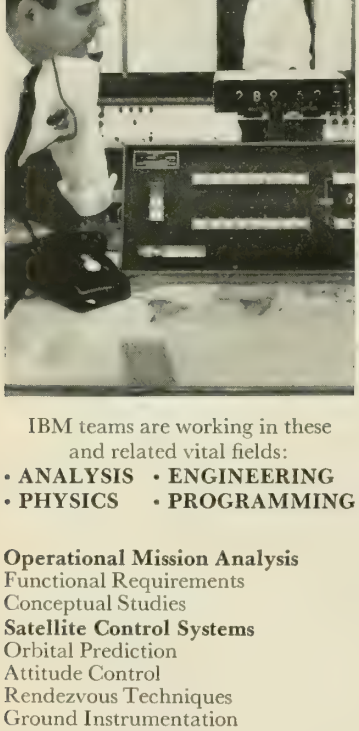
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short-term plan is detailed; our long-range plan involves some very big studies."

Thornton likes to say that his long-range planning involves "visualizing what the blue-chip character of a company will be when it reaches some degree of maturity in this industry."

• **Accenting creativity**—As in the case of its acquisition philosophy, Litton boils its management and organizational philosophy down to one word—creativity. As Ash explains it, "There are always the best opportunities when change is going on. We ask ourselves how we can best go about capitalizing on today's tremendous technological changes. In dealing with change, you can resist it, adapt to it or create it. If you do the last, you can be a leader. Thus we need creative people and we need an organization that can make the fullest use of their creative talents."

This approach dictates Litton's organizational structure. "We steer away from an industrialized structure based on rigid, hierarchical lines," Ash says. "We never could achieve our goals in a hierarchical structure. Some companies are organized so that only the apex—the people at the top—exercise creativity. We want people at all levels and in all departments of the company to make the most of their abilities." As a result, Litton picks what Ash calls "the entrepreneur-types, the creative businessmen" as its division heads. Ash likens them to high-spirited horses which must be given light rein.

Some Litton spokesmen describe the firm as a decentralized organization. They point out that with total employment of 37,500, Litton's headquarters staff totals only 86 persons, including support personnel. But Ash dislikes the use of any label. "We can't say whether we are decentralized or centralized. We look at it in terms of where the creativity is put in. We want it at all levels."

Likewise, Ash and Thornton dislike pinning an "electronics" label on Litton. Recalling that Litton management has sometimes "caught hell" from irate stockholders wanting to know why an "electronics outfit" had acquired this or that company, Thornton said the "so-called electronics industry is beginning to lose some of its identification. We don't sell electronics. We sell new technologies." ⁂

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## optics

# Masers Proposed for Voice Communications in Space

UTICA, N.Y.—Two engineers claim that optical masers can be used to transmit voice communications over interplanetary distances.

An arrangement including a laser transmitter and a receiving system designed around photomultipliers operating in the 3200-5000 A region would be capable of functioning over distances of the order of $10^8$km over a 3kc bandwidth, according to Vincent J. Corcoran and F. W. Griffith of Astromarine Products Corp. in Illinois.

In a paper presented at the Institute of Radio Engineers' Eighth National Communications Symposium, held here recently, the two authors note that use of photomultipliers of the type proposed would involve significant noise—background cosmic noise, dark current noise, and photoelectric shot noise.

But they report that with the system design they propose background noise can be reduced by either receiver field-of-view shifts or spectral filtering. Dark current noise can be decreased, they claim, by reducing the photosensitive area or lowering photocathode operating temperature.

In the basic system concept for the laser transmitter, the output of the low-level oscillator is passed through a mode selector which eliminates the unwanted oscillator modes. The laser beam is then modulated at audio frequencies or at a subcarrier oscillator frequency on which the audio information has been impressed. A traveling-wave laser amplifier is used to increase the signal power, with fiber optics employed in the final antenna feed design.

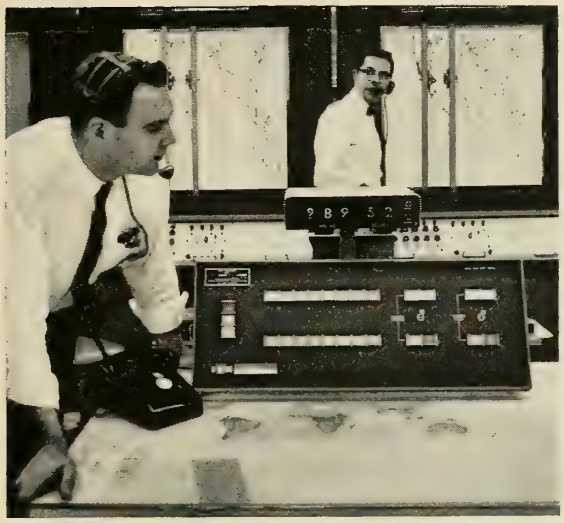
The authors note that with the oscillator-amplifier type of transmitter, mode selection and modulation can be accomplished at low levels, resulting in improved efficiency.

In the receiver, radiation is collected and passed through a narrow-band spectral filter to cut background radiation. A multiplier photo tube detects the signal, which then goes to a conventional communications receiver.

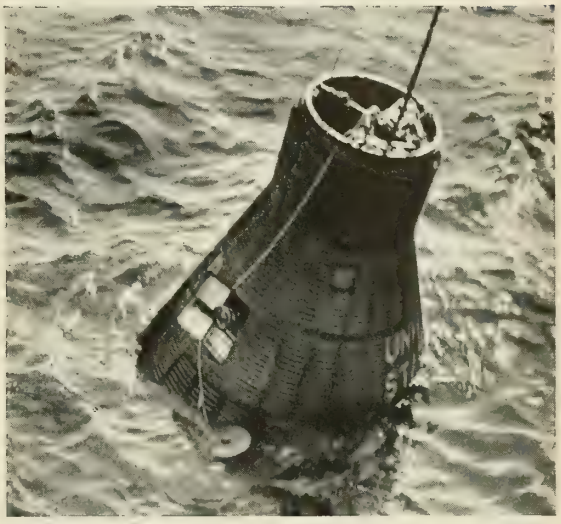
Considerable R&D is still required in several aspects before a practical working system can be built, the authors concede. On the other hand, they observe that all the functional components of the optical system—except the CW amplifier—now exist as experimental devices. ⁂

**IBM** asks basic questions in space

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Manned satellite tracking requires up-to-the-second information. To tell us where a MERCURY spacecraft is now and where we should look for it next, an IBM computer system at the NASA-Goddard Space Flight Center has been linked to ground tracking stations. This system connects sensors, real-time communications channels, data processors, and displays into an information network. It transforms data from space into continuous predictions of flight—from launching, through orbit, to impact.

Space information systems must squeeze thousands of complex computations into split seconds. To reduce computation time requirements, IBM engineers are investigating the application of advanced computing techniques—such as associative memory and auxiliary storage of precalculated data—to space systems. To enable tracking systems to operate in real time, they have developed special communications channels for PROJECT MERCURY and other projects, speeding data into central computers and back to tracking stations around the world. In another area, under contract to the Radio Division of the Bendix Corporation, IBM has designed a data processing system for real-time control of an Electronically-Steerable Array Radar (ESAR). This new approach to handling data in radar systems makes it possible to switch the direction of radar beams with far greater speed than was possible by using mechanical methods—so that one radar can track many satellites and space vehicles simultaneously.

Tracking systems will improve as we learn more about space. Present atmospheric models are static. Their failure to reflect the ebb and flow in the density of the air forces us to approximate orbital permutations due to atmospheric drag. By feeding data from satellites traveling through the atmosphere into an IBM 7090 computer at the Smithsonian Astrophysical Observatory, IBM scientists are plotting air density as a function of deceleration. The dynamic atmospheric model to emerge from their work will make predictions of space flight in the region lying between 150 and several hundred miles from earth more accurate . . . an important step toward the precise control needed for the space systems of the future.

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## DOD Cracks Down on Cuba News

DOD HAS ISSUED stringent new regulations restricting the flow of public information for the duration of the Cuban crisis. Described as a compilation or extrapolation of existing security directives, the guide outlines information considered vital to national security.

Newsmen were asked not to divulge the following:

- Any discussion of plans for employment of strategic or tactical forces of the U.S., including types of equipment and new or planned location of command or control centers or detection systems.
- Estimates of U.S. capability of destroying targets, including numbers of weapons required, size and character of forces required, ability of these forces to penetrate defenses, and accuracy or reliability of forces or weapons systems.
- Intelligence estimates concerning targets or target systems, such as numbers, types and locations of aiming points in the target system, enemy missile and bomber forces, etc.
- Intelligence estimates of enemy plans or capabilities, or information which would reveal the level of success of U.S. intelligence efforts or operations with respect to Cuba or the Communist bloc.
- Degree of alert of military forces.
- Official estimates of vulnerability to various forms of enemy action, including sabotage of U.S. Armed Forces and installations.
- New data concerning operational missile distribution, numbers, operational readiness. Estimates of effectiveness of strike capability of missile forces.
- Details of command and control systems, including new or planned command posts and facilities, estimates of ability to survive enemy attack, security measures, etc., including sea or airborne command posts.

## Soviet Missiles in Cuba

*(Continued from page 14)*

Initially, a Pentagon spokesman said, shipments of defensive weapons such as surface-to-air missiles or Komar-carried missiles would be allowed to continue to Cuba. However, it was indicated that this policy could be changed.

The methods of elimination of already existing missile bases were not revealed. However, if other means are not effective, Defense spokesmen did not rule out the possibility of destroying the sites by aerial bombardment or other active measures.

Under the direct command of Vice Adm. Alfred G. Ward, commander of the Second Fleet, the quarantine task force—designated Task Force 136—is drawn from elements of the U. S. Atlantic Fleet and shore-based patrol and combat aircraft. The exact composition of the force has not been revealed.

It is believed that Ward has available, but not necessarily committed, 4 attack aircraft carriers (including the nuclear-powered Enterprise), 6 cruisers, over 150 destroyers, an ASW force and approximately 87 submarines including nuclear-powered attack submarines.

Aircraft and submarines attempting to carry cargo to Cuba will also be interdicted. ⌘

## The Missile/Space Week

*(Continued from page 11)*

### Cape Building Bids Out

The Corps of Engineers district office in Jacksonville, Fla., has called for bids on several construction projects at Cape Canaveral as the pace of the Manned Lunar Landing program increases.

Largest of the contracts calls for construction of a six-mile-long causeway from the heart of the Cape to the center of the newly acquired land.

The bids will be opened Dec. 13; the project is estimated to cost $2 million.

Bids will be opened Nov. 14 for construction of a $100,000 spin test building where missile components will be checked in a flight simulator.

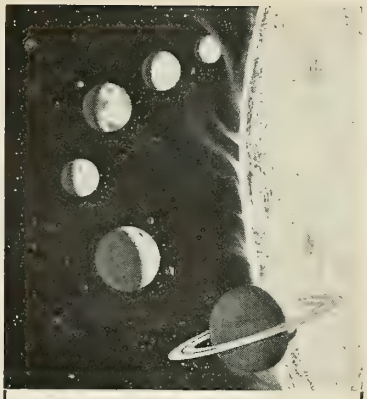
Bids on modification of *Titan* Pad 20 will be opened Nov. 15. The call for bids says the $700,000 project includes extending and strengthening the erector-gantry and umbilical mast to accommodate a larger Air Force missile.

Nov. 19 has been set as the date for opening bids on replacing overhead electrical circuits with underground ducts. Cost is estimated at about $100,000.

Bids on two construction projects will be opened Nov. 20.

The first calls for bids on constructing two-story additions to engineering and lab buildings at Cape Canaveral. Estimated cost of the work is $500,000.

The second group of bids will deal with a $300,000 addition to the base communications building.

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ORIGINALYSIS IN SPACE

## TARGET: The Case for Space

Let's take the weight out of the case and put it in the payload! Why waste energy on heavy packages? High strength-to-weight glass filament-wound structures already have achieved mass ratios better than the egg's .89—and added many more pounds to payload for every additional point gained. This was done by Spiralloy®—Hercules' concept for casing power packages of any size, for Mars and all points in between. Hercules has the capabilities and the competence to undertake any assignment now.



**THE CASE FOR SPIRALLOY**
Hercules originated and developed resin-bonded glass-fiber cases for solid-fueled motors. Over a hundred successful launchings... Polaris (2nd stage)...Minuteman (3rd stage)... Scout and Blue Scout (3rd and 4th stages)... Altair...Antares...have conclusively flight-proved these superlight, superstrong structures. In actual fact, Spiralloy is the **only** glass-fiber motor case with **any** major flight experience!

**NO SIZE RESTRICTIONS**
Filament winding techniques developed by Hercules are adaptable to giant boosters utilizing as much as 10 million pounds of solid propellant, wound at the launching site—or to small production-line components. Complete chambers, end-closure means, nozzles, interstage structures, junctions, clustering systems—all are representative applications.

**SUPERIOR TENSILE STRENGTH**
Spiralloy structures have exceptional tensile properties. Ultimate strength-to-density ratio is about 1,875,000—compared with 1,260,000 for titanium and 990,000 for heat-treated steel. Superior to all other current structural materials in strength-to-weight ratio, Spiralloy is indeed **the** space material.

**HERCULES CAN DO!**
Wherever wound filaments are adaptable, Hercules can do **now.** For technical data on Spiralloy and details on current and potential uses, write Chemical Propulsion Division, Hercules Powder Company, 910 Market Street, Wilmington 99, Delaware.



*HERCULES*

**FIRST IN CHEMICAL PROPULSION**

XP62-2

# soviet affairs

**by Dr. Albert Parry**

### Failures in Soviet rocketry . . .

are gingerly touched upon in a recent article in *Komsomolskaya Pravda.* Titled "Records of Reliability," the story by Yu. Novakov hints (rather than stating outright) that 95% of Russia's launchings to date have been successful, five percent failures. The proportion would have been reversed, says Novakov, without the expert judgment of Soviet scientists and engineers.

"The simplest means of enhancing the reliability of any piece of technical equipment is to double that piece," Novakov writes. "Thus the reliability of radio contact with a spaceship will increase if we install on that ship two sets of radio apparatus instead of one." But he notes that the second set should be used not as an emergency substitute for the first set as a whole, but rather to provide the one or more particular components whose counterparts may have malfunctioned in the original. "The reliability of a set, doubled element by element, is much higher than that of a set replaced in toto," he observes.

Despite the newness of the still-developing theory of rocket reliability, Novakov says, Soviet scientists have reached great successes in its growth."

### Russian research into anti-gravity . . .

has yet to yield an answer as to whether the phenomenon actually exists, according to an article on "Puzzles of Gravitation" in *Krasnaya Zvezda.* Author K. Viktorov declares that "the law of gravity cannot be considered universal. Its effect is limited by a certain area." But he adds that "so far, the interesting question of whether anti-gravity exists has not been cleared up. It is possible that anti-gravity is possessed by the so-called anti-particles which by now have been discovered for almost all elementary particles. To date, however, science has not succeeded in checking this experimentally." Viktorov alludes to other Soviet experiments with gravity, which he says have been successful. These were tests carried out in Russia a year and a half ago which proved, Viktorov reports, that no real handicaps exist for the forces of gravity—"they pass through the body of our planet as freely as if it were an empty space."

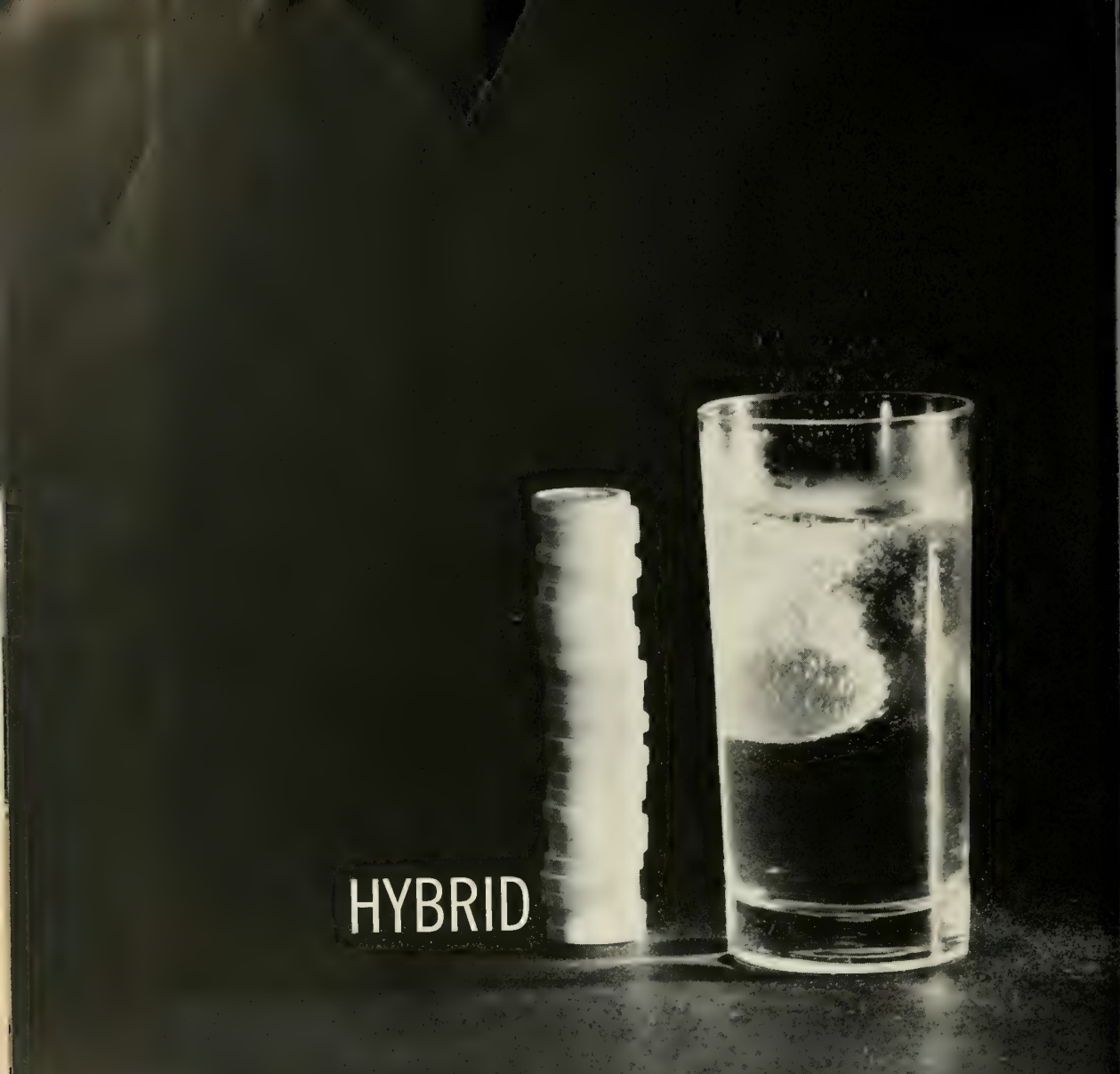
### A chemical information-logic machine . . .

is being researched and built in Moscow's All-Union Institute of Scientific and Technical Information. The Institute's director, Professor A. Mikhailov, recently told a reporter *(Pravda,)* that once it is properly programed the electronic machine will "for instance be able to show within moments in what alloys of metals a certain electric resistance can be found, or a needed durability or a temperature stability is present, also what effect a certain chemical compound has on living organisms."

### Mysteriously new breath-taking ideas . . .

of space feats are ascribed by Cosmonaut Andrian Nikolayev to *Glavny Konstruktor,* the strictly anonymous Designer in Chief of the *Vostok* ships. Writing in *Krasnaya Zvezda* of August 29, Maj. Nikolayev waxes enthusiastic: "The Designer in Chief possesses an extraordinary gift of clairvoyance. I have always been astounded by his ability to penetrate the future boldly and far. He is carried away, he depicts one tableau after another—and you are already torn off the Earth, in your thoughts you are already traveling in the endless space of the great cosmos." He quotes the Designer as telling the cosmonauts: "This, my dear fellows, will happen—will happen without fail. And perhaps it will occur in ways yet more novel and interesting than I now tell you. . . ."

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SELTZER TABLETS. GLASS OF WATER. UNMIXED, YOU HAVE AN INERT SOLID, AN INERT LIQUID. MIX THEM, YOU HAVE IMMEDIATE REACTION. WHAT DOES THIS SIMPLE THERAPEUTIC SYSTEM HAVE IN COMMON WITH UTC ROCKET PROPULSION DEVELOPMENT? UNITED TECHNOLOGY CORPORATION IS WELL ALONG WITH A DEVELOPMENTAL HYBRID ROCKET MOTOR, IN WHICH A LIQUID OXIDIZER IS BROUGHT INTO CONTACT WITH SOLID FUEL. THE RESULT IS A WHOLLY NEW KIND OF PROPULSION SYSTEM, COMBINING TRADITIONAL SOLID PROPELLANT RELIABILITY WITH THE HIGH PERFORMANCE FIGURES CHARACTERISTIC OF LIQUID ENGINES. UTC'S HYBRID OFFERS UNLIMITED START-AND-STOP CAPABILITY, AND HIGHER SPECIFIC IMPULSE THAN ANY OTHER NON-CRYOGENIC SYSTEM. APPLICATIONS: HUGE BOOSTERS, SOFT LUNAR LANDINGS, ORBITAL CHANGES OF SPACECRAFT, CONTROLLABLE BALLISTIC MISSILES. ANOTHER STATE-OF-THE-ART ROCKET DEVELOPMENT BY UTC.

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## SEC Questions ARC Funds Use

The Securities and Exchange Commission has accused certain unnamed Atlantic Research Corp. officials of siphoning off nearly $4 million in corporate funds as loans to enable individuals to buy ARC stock in the open market.

The transaction—allegedly made through various intermediaries—occurred "without specific approval of the board and without public disclosure," the commission charged. By Oct. 12, SEC claimed, approximate amount of the notes totaled $3.9 million.

SEC made the charges against ARC when it extended its temporary suspension of ARC stock on exchanges and over the counter. The public charges and actions, to date, SEC said, do not in any way relate to solvency of the company.

ARC officials refused to deny or confirm any of SEC's statements. They claimed the law prevents their "discussion of such matters while under active inquiry." Commission sources, however, told M/R that ARC is "under no greater restraint against rebuttal than ordinarily—though what they can and cannot say is a ticklish legal question."

One source added, "The commission frowns on certain kinds of statements in such situations" —but would not clarify the point.

In a move apparently related to the SEC action, ARC's board named Arthur W. Sloan, executive vice president, and James M. Johnston, a director, to act as a special interim "finance committee," vested with sole authority over all ARC transactions—apart from day-to-day routine matters. As the board's move was made public by SEC rather than by the company, it was believed in some quarters that commission pressure was responsible for the action.

## Industry Facilities

Wyle Laboratories is expanding its facilities at Huntsville, Ala., to form a million-dollar aerospace test installation. The firm's Westbury, N. Y. test installation will be moved to Huntsville by Nov. 1. Extent and rapidity of further expansion will be determined by rapidity of NASA's own acceleration of its programs in the area, a Wyle spokesman said. . . . *Thiokol Chemical Corp. has opened a new regional office for Rocket Operations in San Bernardino, Calif., The office will serve USAF Ballistic Systems Div. at nearby Norton AFB.* . . . Astrolab, Inc., will move into new, expanded facilities at Springfield, N.J., Industrial Park next month. Astrolab designs and manufactures microwave components used by a number of major missile/space firms. . . . *The Nevada Extension, Space Nuclear Propulsion office, is now operational and assumes responsibility for construction and operation of facilities at the Nuclear Rocket Development Station, located at AEC's Nevada test site. SNPO, a joint office of NASA and AEC, will handle static testing of nuclear rockets at the station.* . . . Northrop Corp.'s move of its Ventura Div. to new Conejo Valley, Calif., quarters will be scheduled to coincide with the firm's year-end vacation schedule. Present Van Nuys facility functions will end with close of final work shift Dec. 21. New operations at Conejo will begin Jan. 7. Employees will be asked to take vacation Jan. 2-4, which are ordinarily Northrop work days. Other exceptions to customary work schedules are planned to facilitate the move. . . . *Colvin Laboratories, E. Orange, N.J., has more than doubled its manufacturing facilities under an expansion program for greater production of pressure and displacement transducers. The firm has increased its personnel by 60% since last January. Greater expansion and hiring of more personnel are expected in the near future.*

## From the Cradle . . .

Industry recruiters are reaching farther down the age scale in an effort to fill expected missile/space manpower requirements. One move is to step up indirect support of school science fairs.

Though most science fairs accept support only from nonprofit organizations, commercial firms often provide the funds with which professional groups finance the awards.

Many companies now offer summer jobs to top science fair winners, hoping to gain them as permanent employees after college. As an added dividend industrial community relations efforts seem to be enhanced by industry participation in science fair programs.

Collins Radio Co. gained nationwide publicity by opening its surplus parts and components supply free to students working on science fair projects. Minneapolis-Honeywell turned over facilities to a science fair finalist to build one of the most sophisticated rockets made by an individual. It then arranged with the Navy for tests of the rocket at China Lake, Calif. An M-H promotional film on the rocket has been shown at schools throughout the country; the student, now in college, is working for the firm.

Public relations through science fairs is big business today. More than three million persons saw nearly 100,000 exhibits built by students last year. A study shows that more than 90% of the finalists at the National Science Fair-International—pinnacle of science fair competition—go on to careers in science and engineering.

AEC, NASA, Navy, Army and Air Force all offer awards at science fairs, as do such organizations as the American Chemical Society and the National Telemetering Conference.

One company spokesman says his firm will next take a look at science exhibits in elementary schools, to see if it should *really* plan ahead.

# contracts and procurements

## AWARDS

### AIR FORCE

$83,960,000—**Morrison-Knudsen, Hardeman, Perini, Leavell and Utal,** a joint venture, Boise, Idaho, for construction of launcher and launch control facilities for the fifth *Minuteman* wing at Francis E. Warren AFB, Wyo.

$40,765,000—**Boeing Corp.,** Seattle, for assembly of *Minuteman* missiles and production of associated spare parts and technical data. Work will be done in Clearfield, Utah and at Seattle.

$33,849,000—**Martin Marietta Corp.,** Denver, for *Titan II* work at Lowry AFB, McConnell AFB, Davis-Monthan AFB and Little Rock AFB.

$28,450,000—**Martin Marietta Corp.,** Denver, for research and development on *Titan II*.

$21,820,000—**Boeing Co.,** Seattle, for work on the *X-20 Dyna-Soar* program.

$12,000,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for work on space programs.

$8,700,000—**North American Aviation, Inc.,** Los Angeles, for research and development work on *Minuteman* guidance and control systems (supplemental contract). Work to be done by NAA's Autonetics Div., Downey, Calif.

$7,125,000—**Martin Marietta Corp.,** New York City, for installation and checkout of *Titan* complexes at Ellsworth AFB, Mountain Home AFB, Larson AFB and Beale AFB (supplemental contract).

$5,000,000—**American Machine & Foundry Co.,** New York City, for work on the *Titan I* launcher system (supplemental contract). Work to be done at Beale AFB.

$4,000,000—**Lockheed Missile & Space Co.,** Sunnyvale, Calif., for work on the *Agena* space program.

$3,648,000—**Aerojet-General Corp.,** Sacramento, Calif., for work on *Titan II* propulsion systems.

$3,100,000—**Radio Corp. of America,** Camden, N.J., for *X-20 Dyna-Soar* communications and tracking equipment.

$2,559,717—**Halvorsen, Inc., and McLaughlin, Inc.,** joint venture, Spokane, Wash., for antenna support facilities for *Titan II* bases at Davis-Monthan AFB, McConnell AFB and Little Rock AFB.

$2,976,680—**Avco Corp.,** New York City, for work on re-entry vehicle (supplemental contract). Work to be done at Wilmington, Mass.

$2,458,440—**General Motors Corp.,** for work on *Titan II* guidance equipment. Work to be done at Milwaukee, Wisc.

$2,400,000—**Radio Corp. of America,** New York City, for final-stage vehicles and services in support of space programs. Work to be done at Burlington, Mass.

$1,986,000—**Paul Hardeman, Inc.,** Staunton, Calif., for installation and checkout of propellant transfer systems for the *Titan* missile. Work to be done at Davis-Monthan AFB, McConnell AFB, Little Rock AFB and Vandenberg AFB.

$1,818,000—**North American Aviation, Inc.,** Downey, Calif., for spare parts for *Minuteman* missile control systems.

$1,700,000—**Martin Marietta Corp.,** Denver, for provision of ground support equipment for the *Titan I* missile.

$1,215,000—**American Machine & Foundry Co.,** New York City, for work on the *Titan I* launcher system (supplemental contract). Work to be done at Vandenberg AFB.

$1,115,185—**General Dynamics Corp.,** San Diego, Calif., for work on the *Atlas* missile program.

$1,109,714—**General Dynamics Corp.,** New York City, for equipment, spare parts and test equipment for installation and checkout of *Atlas* missiles.

$1,031,378—**David Clark Co., Inc.,** Worcester, Mass., for 320 full-pressure flying suits (supplemental contract).

$1,000,000—**Massachusetts Institute of Technology,** Cambridge, Mass., for research and development on the *Titan II* inertial guidance system (supplemental contract).

$1,000,000—**General Dynamics Corp.,** San Diego, Calif., for work on the *Atlas* missile program.

$450,000—**Alco Products, Inc.,** Chicago, for manufacture of heavy-duty springs and spring assemblies to be installed in *Minuteman* missile sites.

$96,066—**Electro-Optical Systems, Inc.,** for development of a high-intensity light pump for lasers for Navigation and Guidance Laboratory, Wright-Patterson AFB, Ohio.




SUBMARINE FBM TRAINING FACILITY, designated 21A37/1, faithfully reproduces cruising depth, position, surface weather, wave conditions, distance and direction to the target. A variety of malfunctions for training can be introduced via pre-punched cards. The magnetic drums of the simulator store 2.5 million bits of data relating to the actual equipment installed in the submarine, the missile control center, and the missile tube area. Instructions can be flashed at the staggering rate of 18-million per minute.

## ARMY

$33,236,680—**Martin Co.,** Orlando, Fla., for industrial engineering services on the *Pershing* missile (from Oct. 1, 1962 through Sept. 30, 1963).

$9,761,439—**Douglas Aircraft Co.,** Charlotte, N.C., for airframes for *Nike-Hercules* missiles.

$9,503,303—**Hercules Powder Co.,** Wilmington, Del., for rocket motors and components.

$6,001,575—**Aerojet-General Corp.,** for work on the *Saturn* space program. Work to be done at Huntsville, Ala.

$3,696,950—**Western Electric Co.,** New York City, for work on the *Nike* guided missile systems.

**Hazeltine Corp.,** Little Neck, N.Y., for bright radar displays for the *Nike-Hercules* system. Work to be done at Indianapolis, Ind. (undisclosed amount).

## NAVY

$3,550,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for *Polaris* missile components.

$3,530,000—**National Distillers & Chemical Corp.,** Bridgeport, Conn., for rocket motor parts.

$3,482,595—**Norris-Thermador Corp.,** Los Angeles, for rocket motor parts.

$2,301,903—**General Instrument Corp.'s Radio Receptor Div.,** Hicksville, N.Y., for the manufacture of classified electronic equipment.

## NASA

$1,550,000—**United Aircraft Corp.'s Hamilton Standard Div.,** Windsor Locks, Conn., for development of a space suit for the *Apollo* moon flight.

$636,052—**Dynalectron Corp. of Land-Air, Inc.,** Washington, D. C., for operation and maintenance of automated satellite telemetry data-processing equiment.

**Emerson Electric Co.'s Electronics and Avionics Div.,** St. Louis, Mo., for evaluation of Thermo-Lag heat blocking compounds for re-entry heat protection of advanced manned spacecraft (undisclosed amount).

**International Business Machines Corp.,** Rockville, Md., for ground-based computer systems for use in future manned space flights (undisclosed amount).

## INDUSTRY

$6,404,376—**Cessna Aircraft Corp.,** Wichita, Kan., from **McDonnell Aircraft Corp.,** for tooling and production of wing tank pylons, bomb racks, missile racks and missile pylons.

$1,328,412—**Collins Radio Co.,** Dallas, Texas, from **McDonnell Aircraft Corp.,** for horizontal situation indicators.

$300,000—**Food Machinery Corp.,** San Jose, Calif., from **Boeing Co.,** for assembly and test of support systems for *Minuteman* missiles.

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Purchasing and Contracting Officer
U. S. Army Missile Support Agency
U. S. Army Missile Command
Redstone Arsenal, Ala.

Following items are procured under RFQ AMCPM-PE-PM-6-63-PM. RFQ due date at the respective ordnance districts by 11-19-62. Blanket, electrically heated, *Pershing* guided missile body section: (1) G&C, part no. 10645198-19—for official use only; (2) first stage, part no. 10645196-10—for official use only. Complete technical data package may be examined at the respective ordnance districts—CO U. S. Ordnance District, Birmingham, 2120 Seventh Ave., North, Birmingham, Ala.; CO Boston Ordnance District, Boston Army Base, Boston 10, Mass.; CO Chicago Ordnance District, 623 S. Wabash Ave., Chicago 5, Ill.; CO Cincinnati Ordnance District, 230 E. Ninth St., Cincinnati 2, Ohio; Cleveland Ordnance District, 1367 Sixth St., Cleveland 14, Ohio; CO Detroit Ordnance District, 1580 E. Grand Boulevard, Detroit 31, Mich.; CO Los Angeles Ordnance District, 55 S. Grand Ave., Pasadena 2, Calif.; CO New York Ordnance District, 770 Broadway, New York 3, N.Y.; Philadelphia Ordnance District, 128 N. Broad St., Philadelphia 2, Pa.; CO St. Louis Ordnance District, 4300 Goodfellow Blvd., St. Louis 22, Mo.; CO San Francisco Ordnance District, 1515 Clay St., P.O. Box 1839, Oakland 12, Calif.

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U. S. Army Missile Command
Procurement and Production
Special Contracts Branch
Redstone Arsenal, Ala.
Attn: AMSMI-IXDB

Selected source procurement for services and supplies in connection with Phase II of ARPAT measurements radar installation and tests at White Sands Missile Range, N.M., with Raytheon Co., Bedford, Mass. (Missile & Space Div.). This requirement is synopsized only for the purpose of affording subcontractor opportunities through direct inquiry to the prime contractor.

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Office of Procurement and Contracts
George C. Marshall
Space Flight Center, NASA
Huntsville, Ala.

Automatic capacitor, resistor and diode testing with component handling and packaging capability. Complete specs included with bid set—1 item. RFP-SP-3-862072. RFP due date 11-12-62.




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Specialized coating problems? The Rust-Oleum Corporation specializes in the research, development, and manufacture of coatings for particular problems in the missile and aircraft industry. Skilled Rust-Oleum specialists and technical service personnel are available to work hand-in-hand with you and your organization. May we hear from you?

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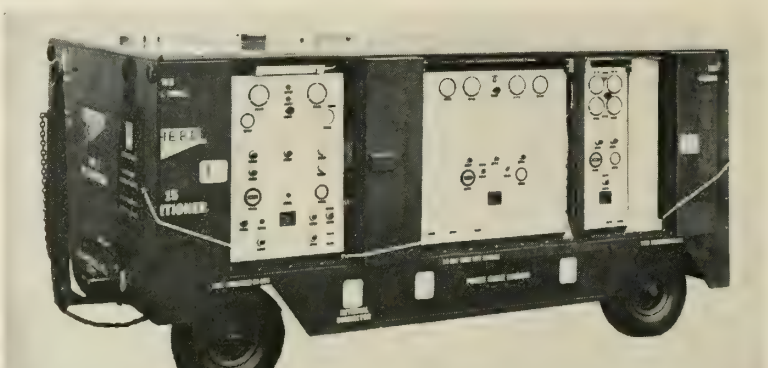


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## New Product of the Week:

## Pre-Flight Conditioner

Modular air conditioner Model 135, available from Advanced Structures Div., Telecomputing Corp., dehumidifies, refrigerates or heats with ambient conditions from 21°F to 100°F. Two or more trailer-mounted units, interconnected with flexible ductwork in series-parallel arrangements, provide a wide range of air-conditioning capacities. Separate heating and cooling modules within a single trailer unit facilitate replacement of a malfunctioning unit and permit use of heating and cooling modules in other applications. Cooling capacity is to 162,000 Btu/hr; heating, to 96,200. Outlet air temperature ranges from 0° to 85°F; inlet, from 21°F to 100°F. Air-flow rate is 50 to 150 lb/min; air pressure at outlet, ¼ psig. Power requirements are 440 volts, 3 phase, 60 cycles, 150 amperes; for remote controls, requirements are 28 volts dc, 50 watts.

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## Data Acquisition Aid

Featuring 0.1% stability and linearity, an all solid-state frequency-to-voltage converter designed for high-accuracy multi-channel data acquisition is being marketed by Vidar Corp.

Ten standard full-scale frequencies are available, ranging from 500 cps to 100 kc. A floating-input circuit design assures high immunity to common-mode signals. High output level (10 volts) of Vidar 321 converters allows direct use with magnetic recorders, digitizers, computers, oscilloscope monitors and other data-processing and control equipment. Output impedance of less than 1 ohm preserves conversion accuracy.

Circle No. 226 on Subscriber Service Card

## Transfer Standard

Voltron Products, Inc. offers its Model 12.583, Voltron-Galman average value transfer standard employing an exclusive voltron circuit development. In it, a broadband operational amplifier is interconnected with a diode bridge to provide a dc output exactly proportional to the true full-wave rectified average of the input waveform, regardless of harmonic distortion or diode non-linearities, over a wide audio-frequency range.

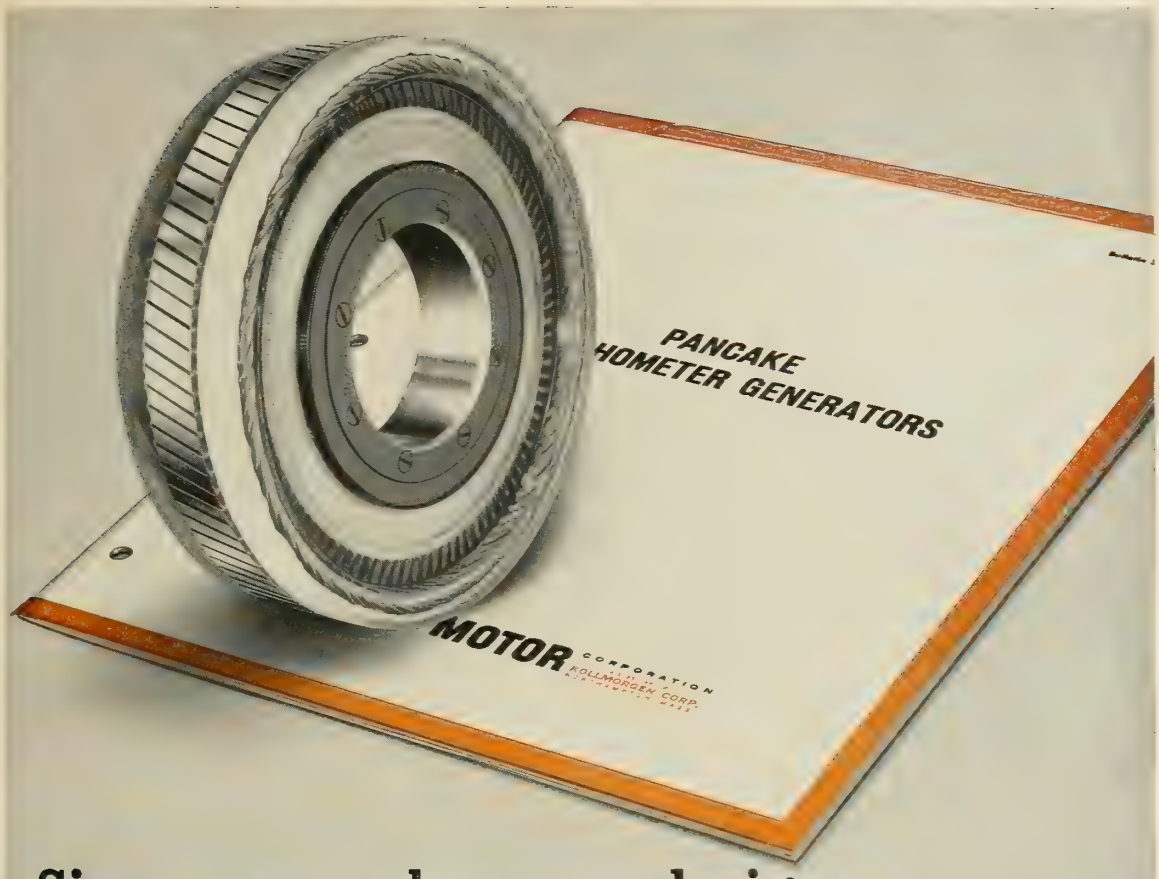
In the Model 12.583, the circuit is combined with an oscillator, a toroidal divider, a saturated standard cell, and a galvanometer for null-balance, to provide 0-300 volts in 10 mv steps at any one or more frequencies between 50 and 3000 cps, to an absolute accuracy of ± 0.01% ± 1 mv. Output impedance is less than one ohm. The unit is completely self-contained and requires no auxiliary instrumentation.

Circle No. 227 on Subscriber Service Card

## Cryogenic Valve

A cryogenic ball valve for handling liquid oxygen is available from Flodyne Controls, Inc. in a remotely controlled type with fail safe characteristics.

This valve is designed for applications requiring the control of flow in liquid oxygen systems with a fail safe




# Six reasons why servo designers specify INLAND D-C TACH GENERATORS for both rate and position control systems

**There are more than 6 reasons!** In fact, you'll find 12 pages of them in our new Bulletin 201, just off the press. Your copy is waiting for your name and address. Meanwhile, let's look at 6 of the reasons why designers prefer Inland Pancake D-C Tachometer Generators.

1. **High resolution!** Feedback from a direct-driven tach generator assures optimum system stability because it eliminates gear backlash and friction.
2. **Rapid response!** Time constants of less than .001 second are possible even when tach output is filtered.
3. **Low ripple voltage** is inherent in Inland Tach Generator design. A special unit has even been made with ripple voltage as low as 0.1% at a basic frequency of 297 times rotor speed.
4. **High sensitivity!** Inland Tach Generators are now serving as rate references for rates as slow as one revolution per year.
5. **Pancake configuration!** Models with axial thickness ranging from 0.500″ to 3.5″ in OD's from 1.937″ to 12.75″ and weights from 0.32 to 40 pounds overcome stringent weight and space limitations. This compact design, common to both Inland Tach Generators and Torquers, allows their integration as space-saving Tach-Torquer units for servo loops.
6. **Long operational life!** Like their torque motor counterparts, Inland Tach Generators deliver up to 10,000,000 revolutions with low-noise wire brushes . . . more than 100,000,000 with silver graphite brushes.

**Get all the facts** about Inland Pancake D-C Tachometer Generators. Write for Bulletin 201 today.

INLAND MOTOR CORPORATION
A SUBSIDIARY OF
KOLLMORGEN CORP.
NORTHAMPTON, MASS.

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characteristic to either close or open the valve with loss of control pressure.

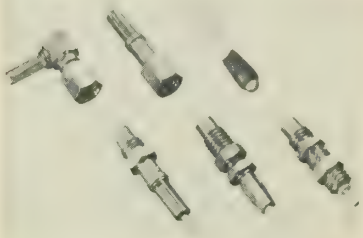
Major features are exceptional sealing tightness in large size valves combined with the lowest of operating torques. Operating mechanisms are isolated from low-temperature fluids and valve is self-venting internally by reason of a unique sealing feature.

Circle No. 228 on Subscriber Service Card

## Microminiature Connector

A series of microminiature RF coaxial connectors has been developed by Tamar Electronics Industries, Inc., featuring captive contacts, crimp type contacts, contact with closed entry, three-piece construction, and assembly time of 45 seconds after wire stripping.

They accept microminiature RG cables from 50 to 95 ohms. Their contact resistance is 0.5 milliohms maximum; minimum cable pull-out force is 15 lbs., temperature range —100°F to 450°F. Designed for high performance and durability, ease of assembly, and crimped terminations, it meets MIL specs on shock and vibration resistance, has universal interchangeability, and excellent electrical characteristics.



Circle No. 229 on Subscriber Service Card

## Patching Center

The Diamond Repeater Co. offers a patching center for digital and control circuits. The unit is designed for 30 duplex trunk channels and up to 60 tie lines. The basic coupler is the DRC Model 6172 repeater set, which can be adapted for the required mode of operation by using the appropriate coupling pad based on a 40-pin plug.

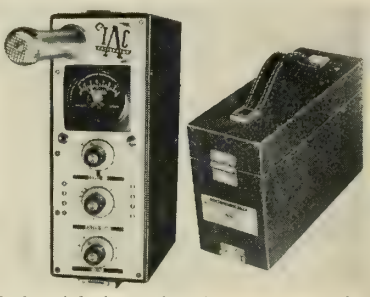
Switching impulses are provided for telex operation and local lines may be operated either neutral or polar, full or half duplex, powered from 48, 60, 80, 120 or 130-volt power supplies located at either end of the line. Current levels may be either 2, 20, or 60 milliamperes.

The rack contains an integral test panel, series jacks, current adjusting rheostats, a bank of current-limiting resistors and protecting fuses. All equipment is designed to meet requirements of data and telegraph centers set up in accordance with telephone, telegraph or CCITT practices.

Circle No. 230 on Subscriber Service Card

## Sound Spectrometer

The IAC sound spectrometer, a compact sound-level meter and octave-band analyzer, has been developed by



Industrial Acoustics Co., Inc. Requiring a low-frequency cutoff at 45 cps, the spectrometer was originally designed with conventional octave bands, the first octave having a sharp cutoff at 37.5 cps.

The unit is available in two models. SS-375 having the conventional octave band scale beginning at 37.5 cps and SS-450 with the ASA scale starting at 45 cps.

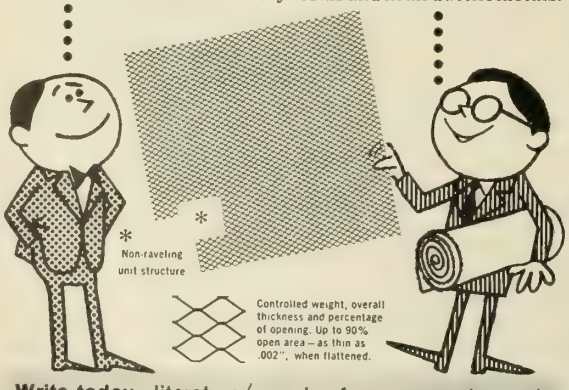
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***What is* EXMET?**

**EXMET *is fine expanded metal!***

Long time users of fine expanded metal who are familiar with EXMET'S know-how and capabilities, frequently refer to fine expanded metal as just "EXMET."

A material ideal for use as grids (battery, tube, lamp and other), shielding, special filtration, strainers and other open area applications. Available in many forms and in all ductile metals.




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# —names in the news—

**Lowell P. Mickelwait:** Vice president, industrial and public relations of the Boeing Co., Seattle, elected to board of directors. **Robert W. Tharrington** named vice president-assistant general manager of the Aero-Space Div. **George H. Stoner** named vice president-manager of the *Saturn* booster branch of the Aero-Space Div. **T. A. Wilson** named vice president-manager of the *Minuteman* branch of the Aero-Space Div. and **George Snyder** named vice president-manager of the *X-20 (Dyna-Soar)* branch of the Aero-Space Div.

**Walter R. Chapman:** Appointed manager of the Product Research and Development Div., Lord Manufacturing Co., Erie, Pa.

**James G. Gaume:** Named to head the Life Sciences Program at the Northrop Corp.'s Space Laboratories, Hawthorne, Calif.

**Sam X. Garcia:** Elected vice president of manufacturing, Hydraulic Research and Manufacturing Co., Burbank, Calif.

**Don S. Randall:** Appointed assistant to the president of Antenna Systems, Inc., Hingham, Mass.

**David Karr:** President of Fairbanks Whitney Corp., New York City, elected chairman of the board. **George A. Strichman** elected president and chief executive officer.

**Leonard F. Verdery:** Named vice president of engineering at Ortronix, Inc., Orlando, Fla., succeeding **Richard S. Bowers** who was promoted to executive vice president.

**Thaddeus L. Dmochowski:** Promoted to executive vice president of the ITT Information Systems Div., New York City.

**David C. Langworthy:** Elected president of Magnetic Metals Co., Camden, N. J.

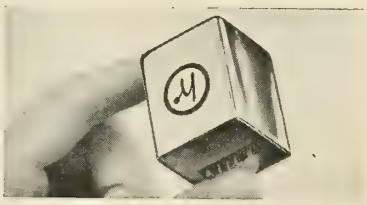
**Philip G. Caldwell:** Named manager of Thompson Ramo Wooldridge, Inc.'s Space Technology Laboratories Northeast District Office, Boston.

**Donald H. Clague:** Appointed manager of material for the Western Development Laboratories of Philco Corp., Palo Alto, Calif.

**Richard A. Arnett:** Appointed manager of the geosciences department of the Science Services Div., Texas Instruments, Inc., Dallas.

**Harry A. Lucas:** Appointed manager of the Systems Marketing Div., Drexel Dynamics Corp., Horsham, Pa. **H. W. Anderson** appointed manager of the Product Marketing Div.

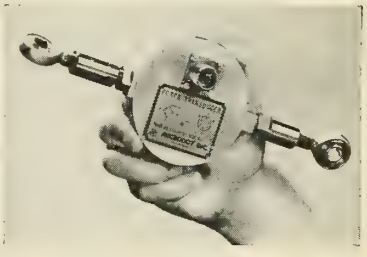
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# NASA

## *november 26* MISSILES & ROCKETS SECOND ANNUAL NASA ISSUE

*During the months following November, the National Aeronautics and Space Administration will make final procurement and development decisions on many major programs: Aeros/Advanced Relay/Nova Super Booster/Advanced Syncom/Lunar Logistics Supply Vehicle/Lunar Exploration Module for the Apollo Spacecraft. Each program means millions of dollars to be spent in the missile/space industry.*

*M/R's editorial task force will visit NASA headquarters and each field center to gather in-depth information on the space agency's present and future programs/budget breakdowns and projections/future contracting procedures/development and launch schedules/new technical requirements/prime and sub-contracting opportunities.*

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# —when and where—

## OCTOBER

**Fourth Annual Western Technical Conference, American Institute of Electrical Engineers,** Biltmore Hotel, Los Angeles, Oct. 29.

**The World Metal Show and National Metal Conference,** New York Coliseum, New York City, Oct. 29-Nov. 2.

**Meeting on Large Rockets,** IAS, El Dorado Inn, Sacramento, Calif., Oct. 29-30.

**American Society of Safety Engineers First Technical Conference,** Morrison Hotel, Chicago, Oct. 29.

**Twelfth Aerospace Fluid Power Conference, sponsored by Aerospace Div. of Vickers, Inc., a division of Sperry Rand Corp.,** Pick-Ft. Shelby Hotel, Detroit, Oct. 29-30.

**Symposium on Dynamics of Manned Lifting Planetary Entry, sponsored by General Electric Co. and AFOSR,** Philadelphia, Oct. 29-31.

**Combined National Fuel & Lubricants, Powerplant & Transportation Meetings,** Bellevue Stratford Hotel, Philadelphia, Oct. 29-Nov. 2.

**58th Meeting National Aerospace Standards Committee, Aerospace Industries Association,** Ko Ko Motel, Cocoa Beach, Fla., Oct. 29-Nov. 1.

**National Conference on Spaceborne Computer Engineering, IRE,** Disneyland Hotel, Anaheim, Calif., Oct. 30-31.

**Ninth Annual Symposium, American Vacuum Society,** Statler Hilton Hotel, Los Angeles, Oct. 31-Nov. 3.

## NOVEMBER

**Sixth National Conference, Product Engineering and Production, IRE,** Jack Tar Hotel, San Francisco, Nov. 1-2.

**Chemtronics Conference, American Society for Quality Control,** Statler Hilton Hotel, Los Angeles, Nov. 1-2.

**Annual Southeastern Regional Meeting of American Chemical Society,** Gatlinburg, Tenn., Nov. 1-3.

**Advanced Technology Symposium, American Society of Mechanical Engineers,** University of New Mexico, Albuquerque, N. M., Nov. 2-3.

**Protection Against Radiation Hazards in Space Symposium, sponsored by the Oakridge National Laboratory and NASA,** Gatlinburg, Tenn., Nov. 2-7.

**Fourteenth Annual Conference on Engineering in Biology and Medicine, sponsored by IRE, AIEE and ISA,** Conrad Hilton Hotel, Chicago, Nov. 4-7.

**Northeast Electronics Research and Engineering Meeting, IRE,** Commonwealth Armory & Somerset Hotel, Boston, Nov. 5-7.

**Symposium on Lasers and Applications,** Antenna Laboratory, Dept. of Electrical Engineering, Ohio State University, Columbus, Ohio, Nov. 7-8.


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**Eighth Annual Conference on Magnetism and Magnetic Materials, IRE,** Penn-Sheraton Hotel, Pittsburgh, Nov. 12-15.

**Retardation and Recovery Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory,** Imperial Motel, Dayton, Ohio, Nov. 13-14.

**Seventeenth Annual Meeting and Space Flight Exposition, sponsored by ARS,** Pan Pacific Auditorium, Los Angeles, Nov. 13-18.

**National Symposium on Materials Compatibility and Contamination Control Processes, Society of Aerospace Material and Process Engineers,** Hollywood Roosevelt Hotel, Hollywood, Calif., Nov. 13-15.

**Mid-America Electronics Conference, IRE,** Hotel Continental, Kansas City, Mo., Nov. 19-20.

**ASME Winter Annual Meeting,** Statler Hilton Hotel, New York City, Nov. 25-30.

**Western States Section Meeting, The Combustion Institute,** Aerojet-General Corp., Sacramento, Calif., Nov. 26-27.

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# Responsibility in Crisis

THE AWESOME THREAT inherent in the weapons which this industry builds was never clearer than in this past week. To live with the knowledge that the moment might be near for their use was to live with a deep sense of depression.

In those depths, for members of this industry, a fateful question was posed: How well would the missiles work?

In the political sense, an ICBM has failed the moment it is launched. But in the technical sense, its test has just begun. Words such as reliability, quality control and circular error probability take on larger meaning in days such as these.

An *Atlas*, a *Hawk*, a *Bullpup* fired in anger must respond unfailingly. Percentages of reliability no longer are important. Test results must be discarded. Nothing less than 100% performance is acceptable.

So the question inevitably arises: Has everyone at Convair, at Raytheon, at Martin done everything possible to assure this? Has the designer put the extra effort into assuring the necessary reliability—or was the lure of the golf course too strong that day? Has the welder taken the extra care to assure the strength of his seam—or was the bowling team beckoning?

The immediate threat, God willing, may pass. But the knowledge that a moment came near—all too near—for the final test of the products of this industry must impress on all its members the tremendous responsibility they bear.

Nothing less than full effort is acceptable to the nation. President Kennedy has called on the American people to face up to the sacrifices which may be necessary. For most, his television speech was a sudden call to responsibility, to acceptance of a crisis which might fade.

For this industry, the responsibility is continuing, not sudden. There can be no sudden decision to work harder, no quick-mend of a system that is less than fully reliable. To engage in the designing, development and building of weapons for this nation is to accept the responsibility for *always*, not *sometimes*, putting forth the best possible effort.

Anything less is betrayal. There can be no last-minute resolutions to do better—it is then too late.

As a people, the Americans are growing soft—softer than the dedicated citizens of the Soviet Union. The members of this industry—government, labor and management—cannot afford that luxury. They must, if necessary, form the dedicated, hard core which will stand fast while others drift. The responsibility is as awesome as the weapons we create.

The action of the International Association of Machinists in taking advantage of the crisis to urge seizure by President Kennedy of Lockheed Aircraft Corp. was despicable. We are not anti-union and never will be. But we read the dispatch reporting this with shame.

We are equally ashamed of the price-fixing activities of executives in this industry which cost the government heavily in defense funds.

We are equally ashamed of the use by the Administration of government contracts as political plums. The Administration must live by the same standards it demands of others.

President Kennedy, in his establishment of a quarantine, took the action required of him by the Cuban buildup of offensive missiles. His decision should receive the fullest support. So should any further decisions necessary to effect the removal of these missiles from this hemisphere.

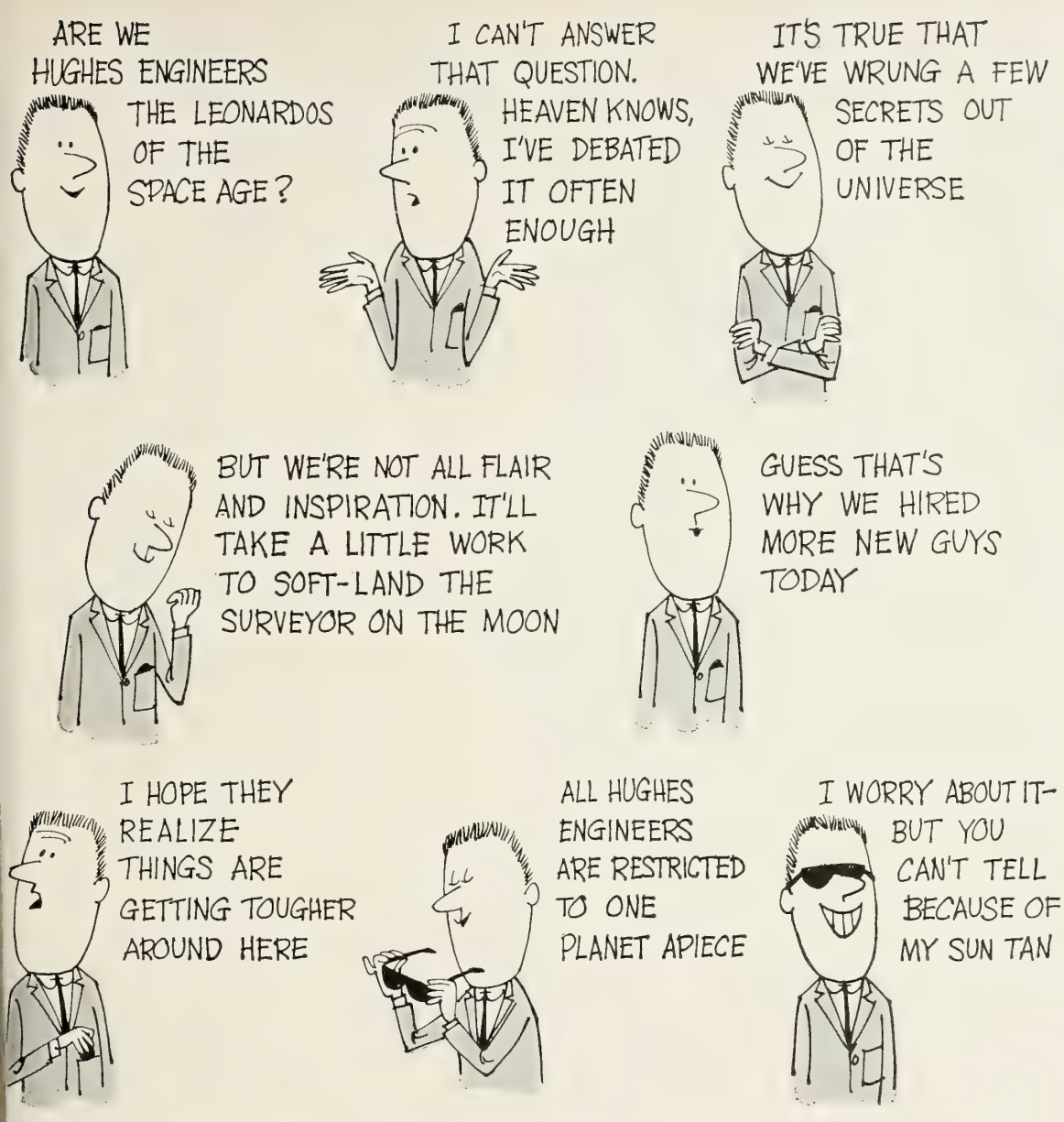
IT IS IRONIC, and not at all comforting, that the Cuban situation has brought the case for the *Nike-Zeus* antimissile missile again into prominence. Dept. of Defense spokesmen have been forced to admit that the U. S. has no defense against the missiles deployed in Cuba.

Proponents of the *Nike-Zeus* system point out that the conditions under which optimum performance could be expected of *Zeus* are precisely those of the Cuban threat. To say that this threat is a sudden development is not true. More than two years ago, this magazine carried a full-page story warning of a possible Cuban missile buildup. Accompanied by a map showing the North and Central American cities which could be hit by Soviet IRBM's based on the island, the story began: "The ominous possibility that Russia will provide Cuba with missiles is haunting U. S. strategists this week." It pointed out that the Soviets had stockpiles of tactical and intermediate-range ballistic missiles which they could send to Cuba for employment at fixed bases or on mobile platforms. The date of that issue was July 18, 1960. The warning went unheeded.

There was no go-ahead for *Zeus*. Any deployment of the system remains years away. Yet *Zeus* is capable of intercept of missiles such as those based in Cuba.

We do not contend that a crash program for *Nike-Zeus* is now desirable with the appearance of this "new" military requirement for it. But we hope that those who demand an immediate and pressing requirement before going ahead with military space programs will learn a lesson from the present perilous situation.

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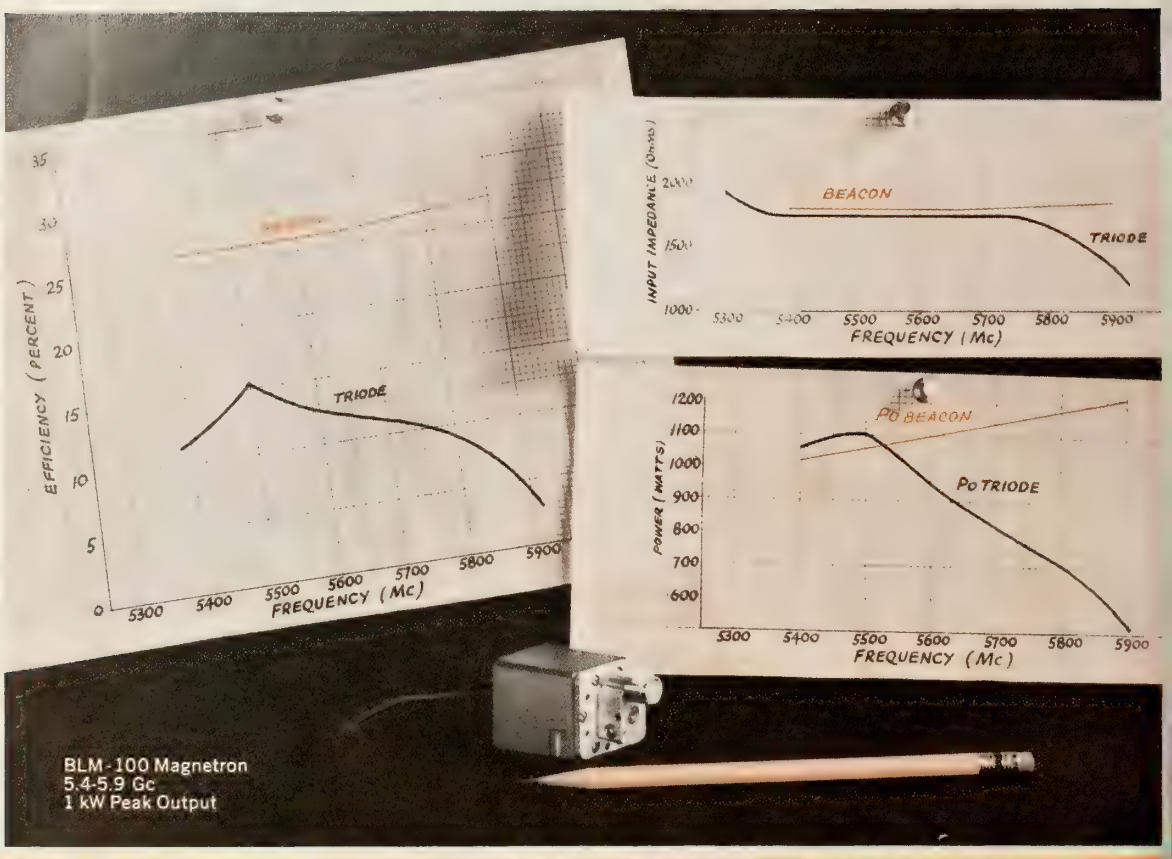


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| 5.4-5.9 | 1.0 | 1.00 | 0.0015 | 2.4-2.7 | 1.7 | 8.5 | BLM-125 |
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NOVEMBER 5 1962

# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

NOV 1962
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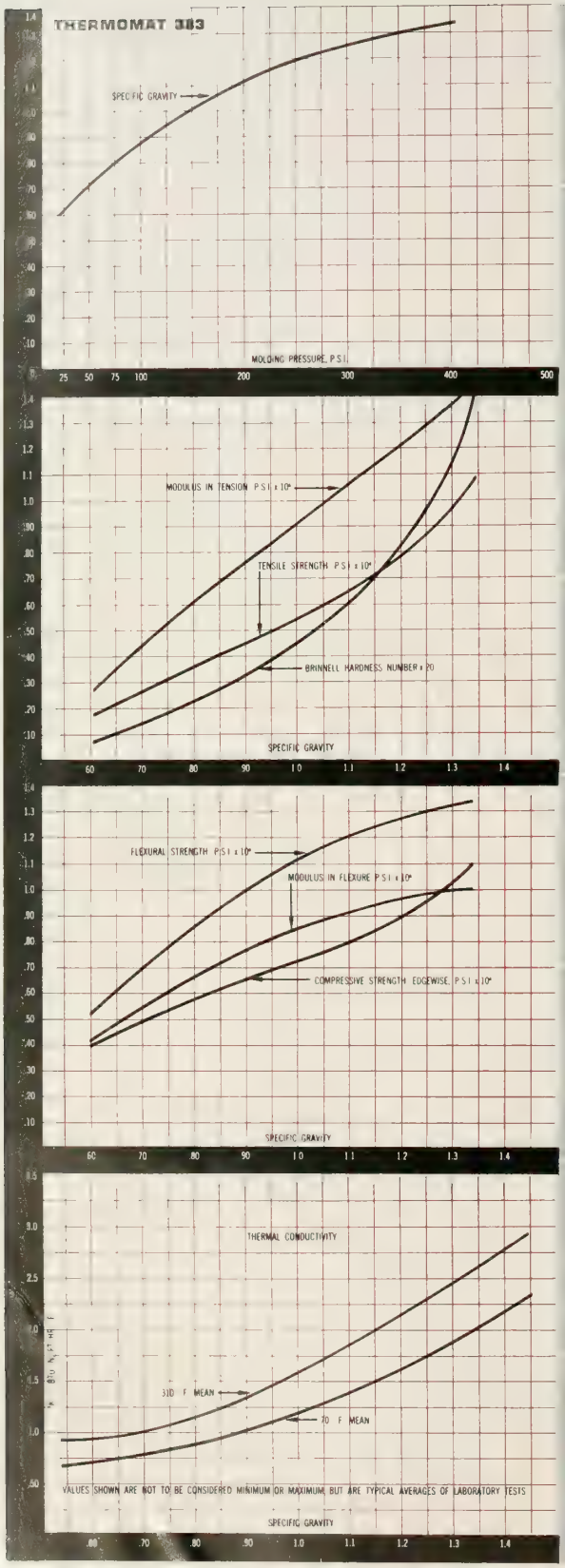


*S-IV Saturn Stage Heads for Alabama*

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 19 November 5, 1962

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*S-IV second stage for NASA's Saturn C-1 space vehicle leaves Douglas Missile & Space Systems Div. in Santa Monica, Calif., on three-week road, ship, and barge trip to Huntsville.* *See p. 16.*



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# letters

## Labor Relations

*To the Editor:*

Personnel working out of this office read your magazine and find it useful and informative, since many of our members are employed in the aerospace industry. However, I was deeply disturbed by the editorial ("Move Over, Mr. Blough") in the Sept. 24 issue. This certainly was the ranting of an uninformed person; he admitted that he didn't know whether union shops are good or bad for the industry. I strongly suspect that this babble was influenced by the center-spread advertisement of Lockheed Missiles and Space Company.

In my opinion, you could be of greater service if you would confine your remarks to missiles and rockets and leave labor relations to people who understand them.

E. R. White
General Vice President
International Association
of Machinists
Washington, D. C.

## Colleges and R&D

*To the Editor:*

Your Oct. 15 editorial, "College Pick: NASA by Five Points," has recently come to our attention. While I agree with you that it makes little sense for research grants from DOD to be limited to an indirect cost rate of 20% of direct costs, while NASA grants are limited to 25%, I cannot agree with several of the statements made in the latter part of the editorial.

I believe I can speak with some authority on this matter, since I was a member of the American Council on Education working group which discussed in great detail with a Government interagency committee the provisions of Bureau of the Budget Circular A-21 on the subject of Principles for Costing Research and Development under Grants and Contracts with Educational Institutions, first issued Sept. 10, 1958.

Your editorial states, for example, that a limit of some kind should be placed on university overhead to ascertain that the Goverment is not being asked to improperly subsidize the universities and indicates that there should not be a free rein to financial opportunists among the colleges. BOB Circular A-21 contains very clear and detailed guidelines for the allowability of both direct and indirect costs in Government grants and contracts. Government auditors are assiduous in interpreting Circular A-21 to insure that the Government is not reimbursing any improper costs. Furthermore, there is a built-in incentive for universities to keep their overhead costs as low as possible, consistent with effective operation, since they must pay out of their own pockets a major share of all overhead costs which Circular A-21 states must be prorated between Government research and all other university activities in an equitable manner. In fact, since a number of normal university indirect costs cannot, under the provisions of Circular A-21, be allocated in any amount to Government research, university overhead rates are normally higher for their other activities than they are for Government work.

Your editorial states that university overhead rates have varied from 10 to 72%, which I believe was also stated by several Congressmen. Although you say these rates were based upon direct costs, I am certain that this is not the case. Practically all universities, with only a few exceptions, compute their overhead rates as a percentage of direct salaries, because it seems to them that this provides a more equitable and accurate method of measurement. However, where the Government has placed limits on overhead, or in studies such as National Science Foundation Reviews of Data on Research and Development in Colleges and Universities, the base used has been direct costs. Comparing an overhead percentage based on salaries with one based on total direct costs is like counting grapefruit and lemons to determine how many will go into a barrel. As indicated in testimony by Dr. Henry D. Smyth of Princeton before the Department of Defense Subcommittee on Appropriations, Princeton's main campus indirect cost rate for 1960-61 was 75.8% of salaries, but only 24.4% of total direct costs (including employee benefits, but excluding all capital expenditures). The 24.4% rate is *below* the national average of 28.2% cited by NSF in the study mentioned above.

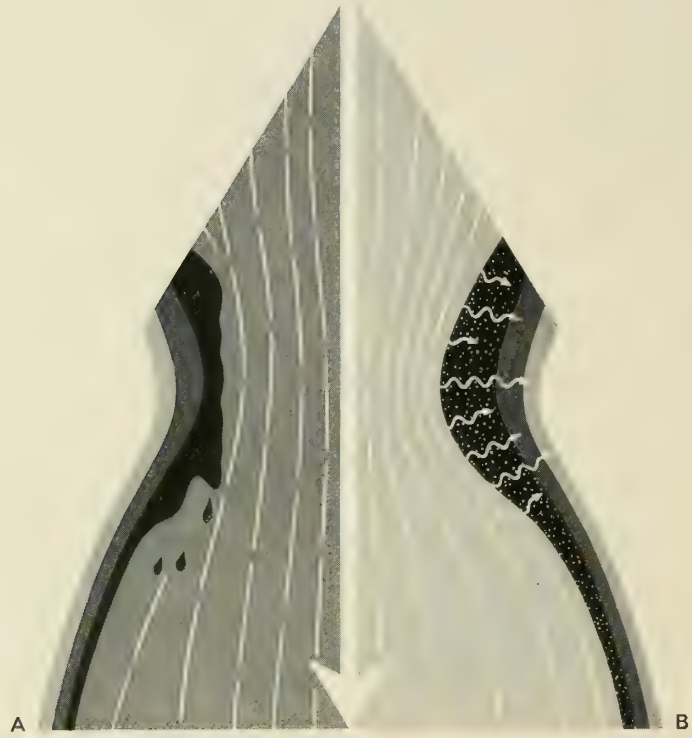
Personnel fringe benefits, secretarial and administrative assistance, utilities, computer operations and so forth are but a few examples of cost which vary in their treatment among institutions. These differences in treatment do not alter the *total cost* of a research project to the Government. This is also true of various industrial organizations whose overhead rates vary widely (although they are almost universally higher than university rates), yet Congress has not dictated limits in these cases—where many more Government dollars are involved. These differences in accounting treatment are a reflection of differences in operational policy and procedure, which should be the master, not the servant, of accounting.

I hope that the above remarks will help to shed some further light on this difficult and complex problem. Your support would be most helpful for the position that I believe practically all universities subscribe to: that they should be reimbursed for the full costs of the research which they undertake for the Government, based on sound accounting procedures and with responsible auditing by the Government.

Raymond J. Woodrow
Director, Office of Research
Administration
Princeton University
Princeton, N.J.

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# AEROPHYSICS




New knowledge of fluid dynamics and heat transfer gradually is forcing a revision in our thinking about solid rocket-nozzle cooling problems. For example, we now know that use of the "two-metal" principle in the design of nozzles permits us to expose metals to temperatures well above their normal boiling points. In the two-metal system, one metal is allowed to boil within another. As boiling occurs, the boiling products of the first metal pass through the pores of the second, thus cooling it by convection, mass transfer, and heat absorption in the phase changes. The above drawings show how hot gases passing through a nozzle (A) erode "pure" metal such as tungsten at the throat. In (B), mass-transfer cooling protects the metal from erosion. This and other cooling techniques permit our design engineers to overcome inherent limitations of materials now available for nozzle applications.

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# The Countdown

## WASHINGTON

### NASA Officials Seek Additional Funds

Top NASA officials are seeking a supplemental Fiscal '63 budget of several hundred million dollars for the manned spaceflight program. Approval has not been given by the Administrator's office or the Kennedy Administration; both are hoping that reprograming of regular FY '63 funds and quicker action on the big Fiscal '64 budget will make the supplemental request unnecessary. This reprograming already has begun, including the switch of $90 million from the construction budget to research and development.

### NASA Wants $6 Billion in FY '64

Space agency officials now are pushing hard for a FY '64 budget of up to $6 billion. Administration budgeting is expected to cut this down to somewhere between $5 and $5.5 billion.

### Space Pact Will Follow a Cuban Settlement

Any easing of the Cuban missile crisis will open the door to signing of a pact for limited space cooperation by the U.S. and the Soviet Union. Agreement will call for exchange of weather satellite data and probably some joint work in communications satellites.

### Castro Delays Large Solids

A meeting of Secretary of Defense Robert S. McNamara and NASA Administrator James E. Webb to thresh out the big solids program was postponed by the Cuban crisis. When the session will be held still is uncertain.

### Space Council to Decide MODS

Decision on whether NASA or Air Force will get the mission for an orbital space station is expected to go to the Space Council. Both agencies are at work on programs for the 1966-67 time period. But a Defense Dept. official says it would be a waste of resources to let both continue into the hardware phase.

### AF Plans Purchase of Gemini Capsules

Latest Air Force plans call for purchase of four or five *Gemini* capsules for an independent AF man-in-space program. Belief is that this will be more efficient than attempting joint projects in a NASA program overcrowded with tests for the manned lunar landing. Decision still is conditional on DOD approval.

### Dominic Tests Pay Off for Missiles

Pacific nuclear tests have paid off with a novel method of packaging nuclear warheads which will increase payload-to-weight ratios while reducing size. Most immediate application: increased yields for *Polaris* and *Minuteman*, previously limited to 600-800 kt.

### Radiation Belt May Last 100 Years

NASA scientists estimate the artificial radiation belt created by last July's high-altitude nuclear explosion will last from 10 to 100 years. Because of loss of data resulting from the fast spin rate of *Explorer XV*, NASA may launch a backup satellite to measure the belt before the end of the year. Both this satellite and its *Delta* booster now are at Cape Canaveral.

### Relay Launch Set for December

NASA plans to launch its low-altitude *Relay* communications satellite from the Cape in December. *Relay II*, originally also scheduled for the last quarter of this year, will not be launched until next year. Exact date will depend on success of *Relay I*.

## INDUSTRY

### Souped-Up Thor To Boost Agena D

Douglas Aircraft Co.'s thrust-augmented *Thor (TAT)* will place an *Agena D* into polar orbit in an early launch from Vandenberg AFB. *TAT-Agena D* is a new member of the *Discoverer-MIDAS-SAMOS* family of Air Force spacecraft with a heavier payload than earlier *Thor*-boosted members. While *Agena D* has flown before, this will be the first test of *TAT*, which has about double the thrust of the Douglas DM-21 *Thor*. *TAT* is a basic DM-21 with three Thiokol XM-33 *Castor* solid-propellant rockets strapped on its sides. It is one of a group of improved *Thors* with strap-on solids designed by Douglas under the name of *Thorad*.

### Lunar Vehicle To Have P&W Engines

NASA's *Lunar Logistics Vehicle (LLV)* will use a Pratt & Whitney RL-10 engine for the spacecraft propulsion unit. The space agency is funding P&W studies into throttling capabilities in order to adapt the RL-10 liquid hydrogen engine to *LLV* needs. The ability to reduce or increase thrust is needed to soft-land *LLV* on the lunar surface.

## INTERNATIONAL

### French Plan 16-Missile Nuclear Subs

First of the French nuclear submarines capable of carrying 16 *Polaris*-type missiles is expected to be operational in 1969, according to the Chief of Staff of the French Navy. The *MSBS (Mer-Sol Balistiques Stratégiques)* missiles will have a range of 1240 to 1865 miles. Present plans call for three of the subs.

### New Rocket in Use at Woomera

A three-stage Mach 10 *Jabiru* rocket is being used at the Woomera, Australia, test range to investigate high-temperature aspects of re-entry. The research vehicle was developed by British and Australian scientists.

### Small ENTAC Has Mighty Punch

Newly-released details of the French *ENTAC* wire-guided antitank missile (M/R, Dec. 4, 1961, p. 18) indicate it is capable of penetrating over 650 mm of armor plate with a 4-lb. shaped charge. The charge, substantial for a 26.4-lb. missile, can be interchanged with a lighter anti-personnel warhead. The missile can be fired either singly or in a salvo of 10 with a completely transistorized fire control unit. Nord Aviation's production rate in 1963 is expected to reach 4000 a month.

### Bell Buys French Target Missiles

Six *CT-41* supersonic target missiles have been sold by France's Nord Aviation to Bell Aerosystems Co., the U.S. licensee. The missiles are to be tested at Pt. Mugu, Calif. A similar evaluation in Britain will be carried out by Hawker Siddeley. The Nord missiles also are currently being tested at the Colomb-Béchar range in the Sahara.




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# The Missile/Space Week

## Cuban Situation Unclear

The destiny of Soviet missile bases in Cuba remained unclear last week.

On his return from Cuba October 31, U.N. Acting Secretary U Thant said he had been told that the bases would be dismantled by Friday, and that all missiles would be shipped from the island shortly thereafter.

President Kennedy, however, immediately ordered resumption of the blockade, beginning November 1 at dawn, until the U.S. might obtain its own assurance that full dismantling was an accomplished fact.

Construction on all Cuban missile sites was believed to have halted Oct. 27 when Soviet Premier Khrushchev ordered Russian offensive weapons out of Cuba.

U Thant's entire party left Havana, but negotiations were to continue at U.N. headquarters.

Thant originally planned to leave his military adviser, Brig. Indar Jit Rikhye of India, to head the observer corps in Cuba that had been expected to be called in immediately from several countries.

## Shots of the Week

• A *Nike-Zeus* launched Oct. 24 from Pt. Mugu, Calif., was destroyed before the third stage ignited. Army spokesmen said all test objectives through second stage ignition and powered flight were met.

• A SAC crew launched an *Atlas-D* ICBM from Vandenberg AFB Oct. 26 in what was described as a routine training exercise.

• The Air Force also boosted an unidentified payload into orbit from Vandenberg AFB Oct. 26 with a *Thor-Agena* vehicle.

• A *Titan II* ICBM roared 5000 miles down the Atlantic Missile Range Oct. 26 and landed in the Ascension Island area in a propulsion and re-entry systems test.

• *Explorer XV* went into orbit Oct. 28 from Cape Canaveral spinning too fast for two of the seven experiments aboard to function. A slowdown from 150 to 73 rpm came when the solar power panels unfolded, but this was still far above the planned 10 rpm. The satellite's spin jeopardizes two experiments designed to measure the decay rate of the man-made radiation belts resulting from U.S. and U.S.S.R. high-altitude nuclear explosions. Five other experiments remained unaffected by the spin rate. The *Delta* launch vehicle marked its 13th straight success.

• Star-seeking equipment and ultraviolet light meters destined for use in the *OAO* satellite were checked out in a launch from Wallops Island Oct. 29. Main purpose of the launch was to investigate two new stars under study by the University of Wisconsin.

• A *Thor-Able-Star* vehicle boosted the 355-lb. *ANNA* beacon satellite into orbit from Cape Canaveral Oct. 31. Photographs of *ANNA's* high-intensity light flashes and computations will result in the most accurate maps of Earth ever drawn (see p. 15).

• A Tactical Air Command crew launched a *Mace-B* air-breathing missile down the AMR Oct. 31. The operation was described as routine training.

• An Air Force *Thor* boosted a nuclear device some "tens of kilometers" over Johnston Island Oct. 26 in the closing stages of the current U.S. nuclear-detonation program. The explosion was in the sub-megaton yield range.

## Advent Report Released

A congressional report cites lack of cooperation between the Army and the Air Force and failure of the Office of the Secretary of Defense to effectively control and direct the services as primary reasons for the costly failure of the *Advent* program.

Congressman Joseph E. Karth (D-Minn.), chairman of the House Science and Astronautics Committee's Subcommittee on Space Sciences, last week endorsed the blistering attack on the Defense Department's conduct of the military communications satellite program.

The report also condemned the cost estimates for the *Advent* program. Initially, the total costs were estimated at $140 million, but by the time the program was cancelled, $170 million had been spent and it was estimated that total development cost would approach $350 million.

Terming these figures startling, the report questioned whether the original estimates bore any relationship to reality.

In view of the difficulties in the *Advent* program, the subcommittee report endorsed a recommendation that the new *Advent* project should be directed by a strong single manager at the Department of Defense level.

DOD officials have consistently maintained that this is unnecessary and have shown no intention of tying together the three agencies now involved in the program under a single manager.

"Serious reservations" were expressed over the DOD plan for a medium-altitude communications satellite system.

## Union Shop Out at GD, NAA

Workers at both General Dynamics and North American Aviation have voted down the union shop in elections urged by President Kennedy.

Only 54% of GD employees at the Convair and Astronautics divisions and 59.8% of the employees at six North American divisions voted in favor of the proposal. Two-thirds approval was required to enforce the union shop provision, supported at GD by the International Association of Machinists and at NAA by the United Auto Workers.

Results of the Nov. 1 vote at Ryan Aeronautical Co. are expected to be made public this week. Though labor observers considered the union showing at North American and General Dynamics surprisingly weak, UAW's position appears stronger at Ryan, where some 70% of the employees are already union members.

The union shop still is a live issue between the IAM and two other aerospace companies—Boeing and Lockheed. Talks with government mediators were still in progress late last week.

## P&W Gets Big NASA Contract

NASA has awarded Pratt & Whitney's Florida Development Center a $19-million contract for advanced work on the RL-10 liquid hydrogen engine designed for upper-stage use with the *Centaur* and *Saturn* launch vehicles.

The work will proceed under a one-year extension of the existing

contract. NASA said this is in addition to work the Marshall Space Flight Center has authorized under another contract.

Marshall has asked P&W to conduct research into throttling capabilities of hydrogen/oxygen engines, using the RL-10. The cluster of six RL-10s that will power the *Saturn S-IV* stage was fired recently by the vehicle manufacturer, Douglas Aircraft Co., in preparation for the first fully powered *Saturn C-1* flight next year.

MSFC also awarded a $660,000 contract to the Vitro Services Div., Vitro Corp. of America, Fort Walton Beach, Fla., to provide support services at the space center's *Saturn* test facility.

Under the contract, Vitro will be responsible for operating electronic data-acquisition equipment used by Marshall in its *Saturn C-1* systems test area.

Karl Heimburg, director of Marshall's Test Div., said use of Vitro would free present personnel operating the test equipment to operate similar equipment in the Center's *Advanced Saturn* lunar rocket test area now under construction.

Vitro's one-year contract becomes effective Nov. 5. It calls for about 80 persons eventually working under Marshall supervision. Vitro will begin its operation with about 30 persons.

## Mariner Experiments Turned Off

NASA reported last week that telemetry from the Venus-bound *Mariner* indicated a sudden change in voltage supplied by the craft's solar panels. Scientists inferred that a voltage regulator problem had occurred.

To conserve power, four interplanetary experiments that had been functioning during the flight were turned off, leaving enough power from the solar panels to supply telemetry communication with Earth and keep the attitude-control system operating.

At the time of Venus fly-by Dec. 14, the scientists will again turn on the interplanetary experiments, as well as two planetary experiments—infrared and microwave radiometers—to obtain data on the planet and its atmosphere.

*Mariner* will get an assist from radar probes being conducted by scientists at Caltech's Jet Propulsion Laboratory.

The radar experiment is designed to bounce radio signals off Venus and analyze the echoes that flash back to Earth. Probing began Oct. 1 and is expected to continue for about three months. Data received from the radar experiment will be compared with that obtained by *Mariner II* when it passes Venus.

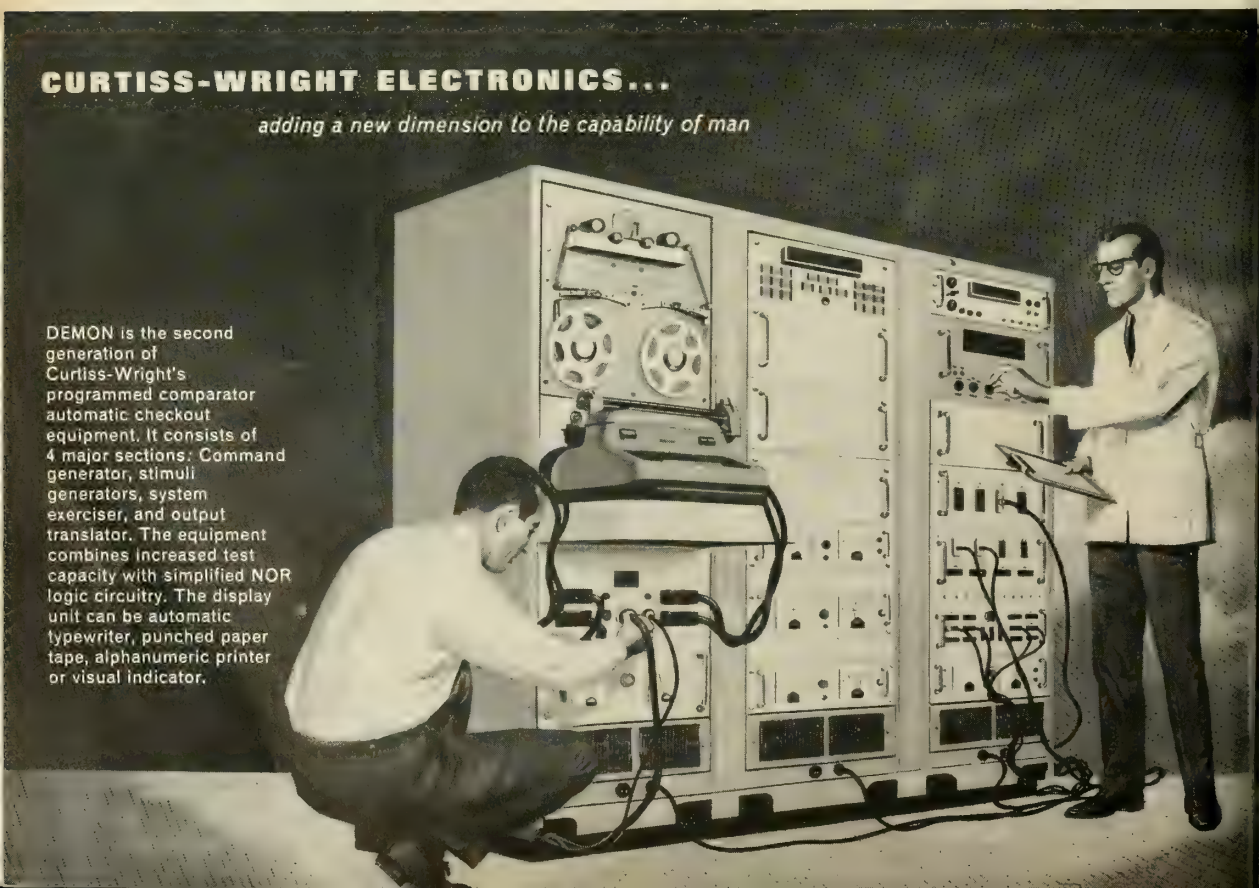
At 8 a.m. Nov. 5 (EST), *Mariner II* was 13,422,736 mi. from Earth, 14,516,206 mi. from Venus and traveling at 14,489 mph.

## Starbird To Head DCA

Maj. Gen. Alfred D. Starbird—until last week commander of Joint Task Force 8 responsible for U.S. nuclear testing in the Pacific—assumed command of the Defense Communications Agency Oct. 29.

The Army general replaces Rear Adm. William D. Irvin, who will become Commander Service Force, Pacific Fleet. Irvin will continue temporarily to serve as an appointee on the Subcommittee on Communications of the Executive Committee of the National Security Council.

Gen. Starbird's sudden assumption of command of DCA came as a surprise. There was no explanation of why he took command before the end of the nuclear test series.

## NASA Realigns Management

Associate Administrator Robert C. Seamans, Jr. announced that NASA has realigned its management structure.

Effective immediately, D. Brainerd Holmes assumes new duties as a deputy associate administrator to Seamans as well as retaining his program responsibilities as director of the Office of Manned Space Flight.

Thomas F. Dixon, who for the past year has served as deputy associate administrator, assumes specific responsibility for NASA headquarters relations with field centers engaged principally in other than manned spaceflight projects.

Most field center directors previously reported directly to Seamans on institutional matters beyond program and contractual administration. Under the new setup, centers reporting on their institutional operations directly to Holmes will include Marshall Space Flight Center, Huntsville, Ala.; Manned Spacecraft Center, Houston, Texas; and Launch Operations Center, Cape Canaveral, Fla.

Dixon's area will embrace operations at Ames Research Center, Moffett Field, Calif.; Lewis Research Center, Cleveland, Ohio; Langley Research Center, Hampton, Va.; Goddard Space Flight Center, Greenbelt, Md.; Flight Research Center, Edwards AFB, Calif.; Jet Propulsion Laboratory, Pasadena, Calif.; and Wallops Station, Wallops Island, Va.

## UTC Claims Throttling Advance

United Technology Corp. reports it has developed a system which throttles liquid-propellant rocket motors by introducing gas into propellant and oxidizer streams just before they enter the thrust chamber.

The gas reportedly introduces bubbles into the stream to alter flow and thrust. Apart from the gas supply, only two valves are added to a motor system for the throttling function.

UTC says the technique is capable of controlling thrust from 100% down to 1% or less of total thrust, works for all sizes of motors, and has "very rapid" response.

## AF Space Needs Listed

Three major needs for further development of military space potential were cited by Lt. Gen. James Ferguson last week in a speech in Philadelphia:

First, due to the high cost of putting a payload into orbit, a rugged re-usable launch vehicle with fast reaction time must be developed.

Second, space propulsion systems must be developed which can provide the necessary large power increments required to make fast changes in orbital planes of maneuvering spacecraft.

Finally, space power sources must be developed not only to meet increasing equipment power needs but also to meet requirements for longer life and greater reliability.

## AEC Seeks Scientists

The Atomic Energy Commission is initiating a nation-wide personnel recruitment program to obtain engineers and scientists.

Salaries will range from $8025 to $17,925 a year.

The recruitment effort, directed by the AEC's Division of Personnel, is focused on obtaining nuclear engineers, nuclear physicists, nuclear safety engineers, health physicists, radiation specialists, physicists, mathematicians, biologists and all other types of biomedical scientists.




*To solve unknowns . . .*

# ARPA Pushes Hybrid Research

***Four new contracts spearhead work as R&D funding soars for all services; flight-test vehicle may follow***

A RAPIDLY accelerated program of research on hybrid rockets has been instituted by the Advanced Research Projects Agency in a determined effort to fill a major gap in U.S. powerplant technology.

Funding has been raised to over $2 million, it was disclosed last week.

Part of Project *Principia,* an overall ARPA program to seek out advanced chemical propellants, the new surge of interest in hybrids has resulted in four major contracts being let, involving a four-fold increase in funding over last year.

The contracts, being carried out by Aerojet, Lockheed, Thiokol, and United Technology, are each aimed at serving the needs of individual services, while in sum total they cover the broad spectrum of ARPA's research goals.

Dr. Gene V. Mock, Assistant ARPA Director for Advanced Propellant Chemistry, told MISSILES AND ROCKETS: "The principal difficulty is in selling the services something that you've neither built nor flown, and that even lacks in theoretical details." It was largely to solve the problem of numerous unknowns and help define the potential applications of hybrids that ARPA decided to accelerate R&D.

Proof of principle and selection of chemical combinations are two major research goals of the new emphasis, which does not yet call for flight tests.

The program's $2 million-plus funding represents more than two-thirds of all U.S. government-funded research into hybrids; by contrast, all research and development prior to 1962 totalled about $2 million.

Dr. R. J. Heaston, Program Manager for the hybrid research, said three of the four contracts recently awarded were for work on the "true" hybrid—one having a solid fuel and liquid oxidizer—and the fourth is for a so-called "reverse" hybrid using liquid fuel and solid oxidizer. (The terms were arbitrarily coined, Dr. Heaston said, to help in differentiating the two types, even though both are hybrids in every sense of the word.)

About 15% of the outstanding contractual effort is to determine the best chemicals to serve as propellant; 60% is for fundamental studies of combustion, grain design, injection, throttleability, and other areas of interest; and the remainder is for hardware research and motor testing.

Contracted work is limited to motors developing a maximum of 5000 lbs. average thrust. Work at lower thrust levels is covered in the contracts.

Follow-on work in additional research depends upon success of the current efforts. Requirements for a flight-test vehicle may be part of such additional development work, although this is not a definitely predicted outcome of any of the four existing contracts.

The future of hybrid research will be determined mostly by how interest develops in each service. As individual services pick up the lead and advance the development of the powerplants, ARPA will phase out accordingly.

• **Advantages** — In citing reasons for pursuing hybrid rocket research, Dr. Heaston listed these advantages of the system: On/off/restart capabilities; throttleability; wide temperature range; liquid-cooled nozzle; thrust vector control via fluid injection; non-explosiveness; high bulk density; simplicity; ability to combine otherwise incompatible ingredients; ease of non-destructive testing; and high performance between that of liquid- and solid-propellant rockets.

"There are always those people who prefer to say that hybrids combine the disadvantages of both liquid and solid rockets, rather than the advantages," Dr. Heaston commented, "and it is true that there are such disadvantages. However, it's exactly the magnitude of these that we are trying to determine, as well as some other problems inherent in the hybrid design."

• **Drawbacks** — Among the disadvantages, he cited low burning rate, difficulty of grain design for the solid portion, and lack of mission analysis.

In the last of these, he said, it is a case of "Which came first: the chicken or the egg?" Without sufficent technology, no one can make a fair mission analysis; the technology is not pursued because no one is sure there is a mission for such a system.

As a result of ARPA action, four companies have been awarded what amount to major contracts for hybrid rocket research. Lockheed Propulsion Co. has a contract from Army Ordnance Missile Command at Huntsville Arsenal; United Technology Corp. has an award from the Air Force Rocket Research Laboratory at Edwards AFB; Aerojet-General Corp. has a contract from Navy's Bureau of Weapons; and Thiokol Chemical Corp.'s Reaction Motors Division has been awarded a contract by BuWeps. (The last of these is for the "reverse" hybrid using liquid fuel and a solid oxidizer.)

In addition, United Technology is working on hybrid rocket combustion problems through a previous ARPA contract, and the Office of Naval Research has awarded a contract under its own funding to Rocketdyne. The Naval Ordnance Test Station at China Lake, Calif., has had an outstanding in-house research program under way for the past three years; and two NASA programs with Thiokol and Lockheed involve studies to determine missions for hybrids in space systems.

The Navy, among all the services, has always expressed most interest in the potential of hybrid rockets, and it is through the Navy that much of the previous research has been accomplished. In formulating the presently accelerated program, ARPA examined the results of in-house research by a number of industry firms, and finally selected 11 companies with previous experience in the field from which to request proposals.

Examination and evaluation of all the proposals was carried out by all the services, so that Army made recommendations on who should get a Navy contract, Air Force voiced opinions on Army contracts, and so on. Of the 11 proposals submitted, four were selected for contract awards, and ARPA noted, with obvious pleasure, that the four companies were unanimously selected by all the services for the work under consideration.

• **Fast action** — Unusual speed

*(Continued on page 43)*

***Despite launch success . . .***

# ANNA's Future Remains in Doubt

***But congressional and scientific support for geodetic satellite may still expand program***

**by James Trainor**

SUCCESSFUL launch of the *ANNA* geodetic satellite last week may revive lagging government interest in the program. But both Navy and NASA are reluctant to commit themselves to a continuing program until after final test results are evaluated.

The program may be allowed to die —since both agencies admit the real problem is a question of available resources and higher-priority programs.

Congressional pressure could change this. A House Science and Astronautics Committee report issued this summer strongly endorsed an expanded geodetic satellite program and recommended that if DOD could not support the program it should be taken over by NASA. The expanded program would include at least five or six satellites and an extensive ground observation network.

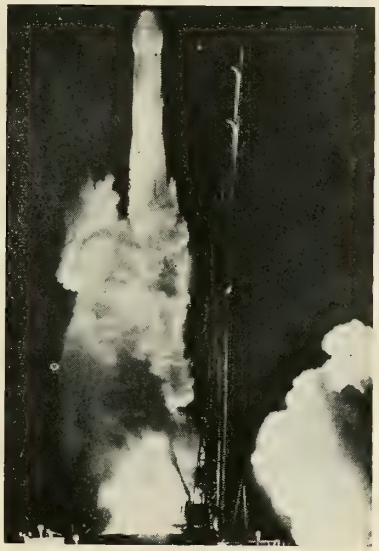
Perhaps the strongest support for the geodetic satellite program comes from the scientific community. Citing the five-year delay in implementing the program, Dr. James A. Van Allen told the committee that "the failure to do this constitutes almost a national dereliction. . . ."

During the 1957-58 period, he recalled, a committee worked out an outline of a national satellite program and "of all the things that we settled on as being of first-rank importance during that period, only the geodetic satellite has not been done in very full measure."

The primary reason for scientific interest in the *ANNA* program: an adequate geodetic satellite program would provide an order-of-magnitude increase in the accuracy of locating positions on the surface of the Earth. At present, these positions are known on a world-wide basis to an accuracy of perhaps 500 ft.—and in some cases the error is a mile or more.

With an adequate geodetic satellite program, geodetic networks on various continents can be interrelated to an accuracy of 30 to 50 ft. In addition, precise observations of the satellites would provide improved knowledge of the geometrical shape of the Earth and its gravity field.

• **ANNA launch a start**—The 355-lb. *ANNA* was successfully launched from Cape Canaveral Oct. 31 into a near-circular orbit by a *Thor-Able Star*. Inclined at an angle of approximately fifty degrees, the 36-in.-dia. satellite had an apogee of 640 mi. and a perigee of 600 mi. All systems were working normally, according to Atlantic Missile Range officials.



*FIRST successful ANNA launch Oct. 31.*

It was the second launch of a geodetic satellite. The first failed to orbit May 10 when the *Able Star* upper stage did not ignite.

In the coming three months, an intensive calibration program will be accomplished in order to prove that no biases exist in the satellite instrumentation or in the data-handling techniques.

After these biases are eliminated or corrected for, a world-wide survey phase will be undertaken to refine the knowledge of Earth's gravitational field and to provide the location of tracking stations relative to Earth's center of mass. Preliminary data will be furnished to the Army Map Service and the U.S. Coast and Geodetic Survey.

Although no plans have been announced on either the observation equipment to be used or the methods of data collection, consideration is being given to use of the Smithsonian Astrophysical Observatory optical network, the optical tracking networks of NASA's Minitrack stations, Minitrack interferometry information, JPL space-probe radar systems and selected foreign observatories. Power limitations of the optical beacon preclude inclusion of all observatories.

• **Satellite instrumentation**—*ANNA* contains three basic types of instrumentation for obtaining position information:

—A transponder for range determination, which, coupled with ground instrumentation, gives a phase comparison between the modulating frequency as transmitted to and returned from the satellite. Analysis of the difference in phase shift on the two returning frequencies permits a correction to be made for refraction effects.

—A high-intensity optical beacon for optical determination of the direction from an observation station to the satellite. Since the beacon consumes a large amount of power, the flash sequences—a series of five light flashes spaced 5.6 secs. apart—are limited to 20 or less per day.

—Ultra-stable transmissions from the satellite to provide range rate information by observing the Doppler shift. Four coherent frequencies, transmitting continuously, are used. Two of these are reserved for refraction studies and for a possible backup in case of failure of the primary tracking frequencies.

None of the instrumentation is optimized for observations by the civilian scientific community, and most of the experiments require complex ground stations and timing signals.

*ANNA* is an acronym for Army, Navy, NASA and Air Force. The program is managed by the Navy's Bureau of Naval Weapons. Overall technical direction and satellite development is supervised by the Applied Physics Laboratory of The Johns Hopkins University. Navy and APL also were responsible for the satellite's Doppler system.

The Army, in cooperation with Cubic Corp., furnished the ranging system; the Air Force provided the optical beacon, under contract with Edgerton, Germeshausen and Grier, and the camera equipment, under an award to Instrument Corp. of Florida. ⌗

*One is NASA's biggest . . .*

# New Saturn Awards Total $333 Million

## *Contracts cover North American production of C-5's second stage, continuing work at Douglas and Boeing*

**by Hal Taylor**

NASA HAS ANNOUNCED three launch vehicle development contracts totaling close to $333 million.

The awards include the largest in NASA history—$319,922,328 to North American Aviation Space and Information Division for the second stage of the *Saturn C-5* booster.

The other contracts include $10.9 million to the Boeing Co. for a two-month extension of its contract for development of the *Saturn C-5's* first stage, and $2.2 million to Douglas Aircraft Corp. for modifications of *S-IVB* upper stage of the *Saturn C-1* booster.

While the signed contract with North American is the largest to date, it is expected to be exceeded in the near future by detailed contracts for other spacecraft and launch vehicles in the Manned Lunar Landing program.

The NAA contract will cover work through 1966. North American will produce nine live flight stages, one inert flight stage and several ground-test vehicles. The *S-II* second stage will be 33 ft. in diameter and 82 ft. in length. It will be powered by five J-2 hydrogen oxygen engines with a thrust of one million pounds.

NASA announced on Sept. 11, 1961, that North American had been chosen for negotiations on the *S-II* contract. Early design has been under way since Oct. 27, 1961, under an interim contract.

The *S-II* will be produced at Seal Beach, Calif., at a facility on a U.S. Naval Ammunition Depot site made available under a use agreement between NASA and the Navy Department. It will be static-tested at North American's Santa Susana, Calif., facility and at NASA's Mississippi Test Facility.

• **Other awards**—The contract with Boeing covers a two-month period from Nov. 1 to Dec. 31, 1962. The interim contract was awarded to continue Boeing work on the five-F-1-engine first stage of the *C-5* until a final definitized contract is signed later this year.

Space agency officials estimate that the final contract, which will also cover work through 1966, will be worth well over $300 million.

The Douglas contract covers minor modifications to the *S-IVB* stage, which is powered by one J-2 liquid hydrogen engine.



*PRODUCTION STAGE of Saturn S-IV stage, together with its special transporter, was loaded aboard cargo ship at Los Angeles Oct. 26. Douglas-built S-IV is the first space vehicle of its size to travel from West Coast to East, via Panama Canal and river barge.*

The stage was originally developed by Douglas as the third stage for the *Saturn C-5* booster. Its mission is to push the manned *Apollo* spacecraft into Earth-escape trajectory during circumlunar and lunar-landing missions.

NASA recently decided to develop the *Saturn C-1B* booster composed of the regular *S-1* first stage and a modified *S-IVB* second stage.

The *S-IVB*, in its new assignment, will boost the manned *Apollo* spacecraft into Earth orbit to check out and test the *Apollo* system in preparation for future flights to the Moon.

Currently, the stage is in the early development phase at the Douglas Missile and Space Systems Division.

*S-IVB* work is presently programed for the company's new space systems center in Huntington Beach, Calif., which will be operative in the fall of 1963.

Static firing of both versions of the *S-IVB* will be accomplished at the Douglas Sacramento Facility, which at the present time is engaged in testing another NASA *Saturn* upper stage, the *S-IV*.

The *S-IV*, also being developed by Douglas, will be the second stage of NASA's *Saturn C-1* booster. It is made up of six RL-10A3 engines with a total thrust of 90,000 lbs.

One of the stages recently began a trip from the Douglas plant to NASA's Marshall Space Flight Center. The stage is a dynamic test vehicle which will be assembled and tested at Marshall.

The trip will take about three weeks. The vehicle will remain at Marshall for about six months, after which it will be returned to Douglas for a series of structural tests.

At Marshall the unit will be mated vertically with other *Saturn C-1* components in a 200-ft. tower for a series of bending and vibration tests.

The first flight test of the *S-IV* stage will be made in 1963.

During the trip to Marshall, the stage was transported 35 miles to Los Angeles harbor on a specially built 25-ton transporter. It was loaded on a steamship (see photo) for its journey through the Panama Canal to New Orleans.

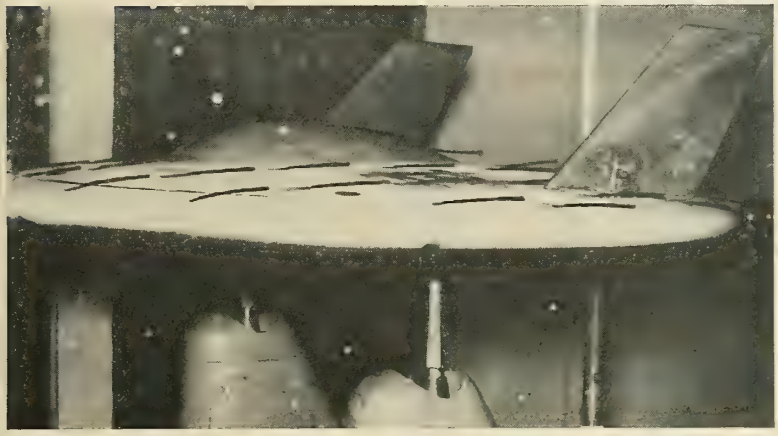
At New Orleans the vehicle will be placed aboard a barge for the 1100-mile trip up the Mississippi, Ohio, and Tennessee Rivers to the Marshall Center. ⁂

## 300 attend symposium . . .

# Lifting Vehicle Problems Attacked

### *Concepts include use of pre-stressed pyrolytic graphite in nose caps, exploiting plasma sheath*

by William Beller



*WIND-TUNNEL model of Fairchild Stratos landable-disc re-entry vehicle.*

PHILADELPHIA — The post-*Apollo* challenge of devising lifting vehicles to enter planetary atmospheres is demanding research as new and strange as the environments to be studied.

One major result is that inter-discipline attacks are being mounted against the technical problems involved. The first organized meeting occurred here last week at the "Symposium on Dynamics of Manned Lifting Planetary Entry," jointly sponsored by the Air Force Office of Scientific Research and the Space Sciences Laboratory of General Electric Co. More than 300 invited scientists participated.

• **Pre-stressed pyrolytic graphite**—A big stride forward in maintaining the strength of a nose cap of a re-entering vehicle was revealed by GE engineers A. M. Garber and E. J. Nolan.

The concept, called "spectacular" by many in the audience, involves manufacturing boron-pyrolytic graphite —a highly anisotropic material—so that it emerges in a pre-stressed condition. Thus the thermal stresses caused by the re-entry environment will oppose and cancel, in part, the built-in stresses; this induces decreasing stresses as the vehicle flies through its trajectory.

Hence, the boron-pyrolytic graphite serves two purposes: it provides a heat shield, and it maintains structural integrity.

The authors added that the surface recession resulting from the oxidizing environment can be of the order of one-tenth that of conventional graphites.

• **Plasma power** — The ionized plasma sheath surrounding a re-entering vehicle might possibly be used to generate substantial amounts of electricity. Such power could be used to help break through the sheath for communications purposes, or possibly to alter the wake of the body sufficiently to smear its military signal.

John R. Radbill, North American Aviation scientist, conceives of an electrodeless MHD generator interacting with the flow outside the vehicle and having a structure similar to that of a conventional induction generator. The windings may be single-phase or polyphase, and the frequency several kilowatts.

Radbill said tests of a small model yielded electrical outputs of three to four watts.

• **Re-entry shapes**—Several lifting re-entry configurations were proposed.

A team of authors—M. L. Buck, B. R. Benson, T. R. Sieran, and R. D. Neumann—from the Air Force Aeronautical Systems Division proposed a glide entry vehicle called SORTIE, an acronym for Super Orbital Re-entry Test Integrated Environment.

The vehicle is described as "a modified blunt elliptical cone" that could also be considered as "a logical extension of the efforts of the NASA *Mercury* and *Apollo* programs—for the next logical step from the NASA vehicles is a lifting entry type of vehicle."

A "flying saucer" re-entry vehicle was proposed by P. A. Giragosian and W. D. Hoffman of Fairchild Stratos. The underside of the "saucer," or disc, is the heat shield—similar in design and function to the blunt face of the *Mercury* or *Gemini* capsules.

Transition to gliding flight is made by unfolding control surfaces on top and to the rear of the disc. The vehicle, flying at relatively low glide angles, is to land either on its heat shield or on retractable skids.

• **Venusian atmosphere**—New information about the temperatures within the atmosphere of Venus was disclosed by Lewis Kaplan, chief of planetary studies at California Institute of Technology.

He said a recently renewed analysis of Mt. Wilson spectrograms made 30 years ago indicates two peaks in the temperature curve: one at 800°F taken as the ground temperature; the other at 100°F taken as an intermediate cloud layer.

These results, Kaplan said, augment more recent observations made through microwave techniques and the 200-in. Mt. Palomar telescope. The emerging profile of Venusian temperature distribution: −40°F at the top of the cloud layer; temperature increasing as altitude decreases; average cloud temperature 350°F.

Kaplan observed that the strong greenhouse effect necessary to maintain the planet's high surface temperature probably is caused by clouds of condensed hydrocarbons together with the undoubtedly large amounts of carbon dioxide present.

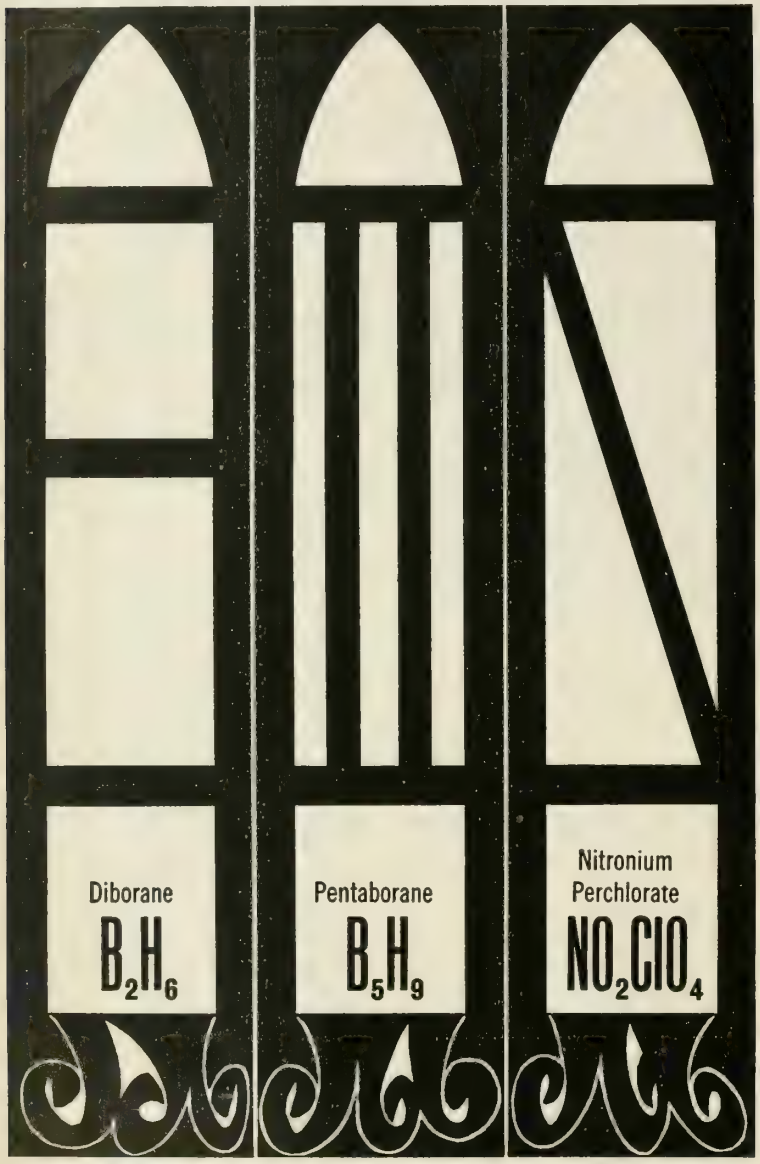
"The next step is to try to identify the spectra of these (hydrocarbon) molecules," Kaplan said, "and we are presently engaged in such a search, particularly in the millimeter region, which has not yet been scanned."

• **Transmitting through plasma**—Five possible ways to communicate through a plasma medium were outlined by M. P. Bachynski and G. G. Cloutier, of RCA Victor Research Laboratories.

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*tions.* The choice of the high frequency to employ is strongly influenced by the expected value of the electron density within the plasma sheath surrounding the re-entering vehicle.

Another factor, equally important, is the absorption of the electromagnetic radiations by the surrounding planetary atmosphere of free molecules and suspended particles. These are oxygen and water vapor in the Earth's atmosphere.

The authors say that although air-to-ground communications by high-frequency emanations may not be feasible because of oxygen absorption, air-to-air communications may be not only possible but highly desirable from the standpoint of added security for astronauts.

*Low frequency.* A low-frequency emission passing through the plasma sheath will be attenuated by an amount that can be calculated; a sufficiently powerful signal can therefore be pushed through.

The only other consideration is "the bandwidth of the information the low-frequency signal must carry, since a lower-frequency signal of necessity implies a narrower bandwidth of possible information."

*Magnetic fields.* When a magnetic field is present, a plasma becomes "transparent" to certain electromagnetic radiations.

In general, however, the field strength needed is relatively high—more than several hundred gauss. This means the power-supply requirements may become overwhelming.

The authors propose using superconducting materials to help generate the needed magnetic field, even though there may be problems in cooling the alloys to superconducting temperatures.

*Chemical seeding.* The electron density of a plasma sheath can be modified either upward or downward by appropriate seeding with chemical additives. For example, one way to decrease electron density is to change the electron recombination time.

This can be done by introducing water vapor into the plasma, which, in turn, decreases the electron density and thus reduces the attenuation of an r-f signal trying to get through the plasma.

*Aerodynamic effects.* Advantage can be taken of any aerodynamic phenomenon that can decrease the temperature of the plasma, thereby decreasing its degree of ionization, the electron density and the attenuation of the r-f signal.

Transpiration cooling may be one answer. That is, forcing an evaporating fluid through pores in the vehicle's skin.

Another way would be to put the receiving or transmitting antenna in low-temperature spots on the vehicle's body. This of course calls for considerable design ingenuity. ⁂



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# An idea grows from one mind to another.

It may begin with nothing important. Just a word. Or a notion. But as each succeeding mind brings a fresh viewpoint, the idea begins to grow and mature.

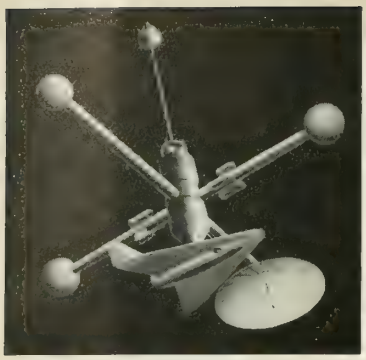
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**Aerospace Traffic Control Center**
**Timetable: 1970's**

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The station—aerospace traffic control center of the 1970's—will be assembled in orbit in a series of pieces brought together by rendezvous techniques. Included: Command center; living quarters; maintenance station; radar and infrared sensing devices; nuclear power supply; communication links with the earth and other space vehicles. As now planned, 12 people will man the vehicle. Their tour of duty will be measured in weeks.

For four years Lockheed-California Spacecraft has concentrated on the needs of man in space. Activities embrace all fields pertaining to development of such complex spacecraft, as well as related supporting technologies: Space physics (radiation hazards); astrodynamics (rendezvous); biophysics (human engineering); metallurgy and manufacturing processes (materials and structures).

**Scientists and Engineers** of outstanding talent and training are needed to develop the new Spacecraft concepts of Lockheed-California in the following fields: Digital Communications; Antennas and Propagation; Advanced Systems Planning; Bioastronautics and Space Medicine; RF Equipment; Astrophysics; Astrodynamics; Communications Analysis; Aerophysics; Tracing, Telemetry, Command Engineering; Weapons Effects; Operations Research; Theoretical Physics. Write: Mr. E. W. Des Lauriers, Manager, Professional Placement Staff, Dept. 1711, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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# NASA Moves to Ease Policy on Patents

RECENTLY ANNOUNCED changes in NASA patent policy could make over 200 space agency patents available to U.S. industry.

The changes include new regulations under which industry can get a lincense to use NASA-owned patents and proposed rules under which NASA will waive its right to patent ownership.

The licensing regulations, which became effective on Oct. 26, provide that NASA will offer industry companies revocable non-exclusive, royalty-free licenses to use for two years patents which it owns.

If, after two years, a firm holding a license does not work the patent, NASA will make the invention available to other firms through the grant of an exclusive license.

The regulations also guarantee that the firm which developed the patent under a NASA contract will not be deprived of its right to use it.

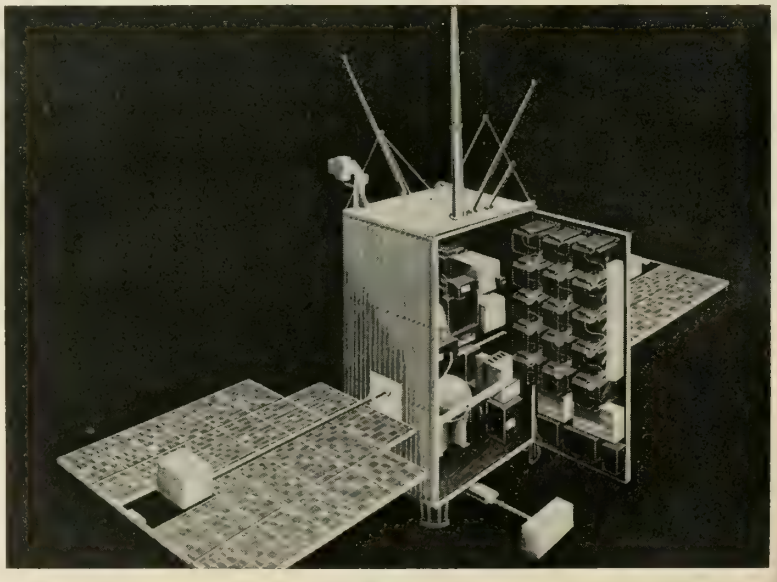
The proposed waiver rule applies to those cases in which NASA decides to give up its right to the title of a patent to the firm which developed it. It provides that if the patent is not worked three years after NASA waives its ownership rights, the space agency can grant other firms non-exclusive, royalty-free licenses to use it.

• **List to grow**—A NASA official estimated that well over 200 patents will be affected by the recent changes. This includes 50 patents which NASA now owns and 175 inventions on which NASA has applied for a patent.

The number is expected to grow by leaps and bounds as NASA's research and development programs expand. For example, NASA contractors have discovered 1300 inventions since the space agency's inception—and half of these have come in the last year. Officials said that NASA will probably apply for patents on 25% of the inventions.

While the announced and proposed changes liberalize NASA policy to a certain extent, they are still far more restrictive than the patent policy supported by the U.S. missile/space industry.

Under the Space Act, NASA retains



***New POGO Concept Shown***

*NINETEEN experiments will be aboard the first Polar Orbiting Geophysical Observatory (POGO), which NASA plans to launch early in 1964. The spacecraft will test Earth's magnetic fields, auroras, and cosmic rays, and is built by Space Technology Labs.*

title to all patents developed by its contractors unless it decides to waive its ownership rights.

Industry wants NASA to switch to the Dept. of Defense patent policy, under which contractors retain ownership to all patents. But such a change in NASA policy would require congressional action and is not likely to come in the near future.

The licensing regulations are a liberalizing factor because they increase the number of firms which can make use of NASA patents.

The proposed waiver rule, however, remains restrictive. The current rule is that NASA must wait five years before it can license other firms to use the patent if the contractor has not worked it. The proposed rule would simply reduce the wait to three years.

NASA will hold a public hearing on Dec. 10 to get industry views on the proposed waiver rule. Firms wishing to make oral presentations must notify the space agency by Nov. 19.

The proposed rule provides that a prima facie case for waiver of title may be established by showing that:

—The invention is in a field of technology in which the contractor has an established commercial interest and in which, prior to such contract, it had acquired technical competence demonstrated by factors such as know-how and patent position; or

—Waiver of title to the contractor would be an effective incentive to work the invention at the earliest practicable date because of the substantial expense or investment required to do so; or

—The invention was conceived prior to the contract of the Administration under which it was first reduced to practice and independently of any other contract of the Administration and is covered by a United States patent application filed prior to the contract.

Waiver of the title will not ordinarily be granted in the following cases:

—Where the invention is in a field of technology in which there has been little significant prior experience outside of work funded by the government and the acquisition of exclusive rights by the contractor might lead to domination of that field.

—Where the invention constitutes an end item which is likely to be required for use by the public by law or governmental regulation in furtherance of the public health, safety, or security.

—Where the invention has primary utility in a field of technology in which research has depended to a major degree upon support from the Government in programs designed to create, develop, or improve goods or services intended for use by the general public. ⌘


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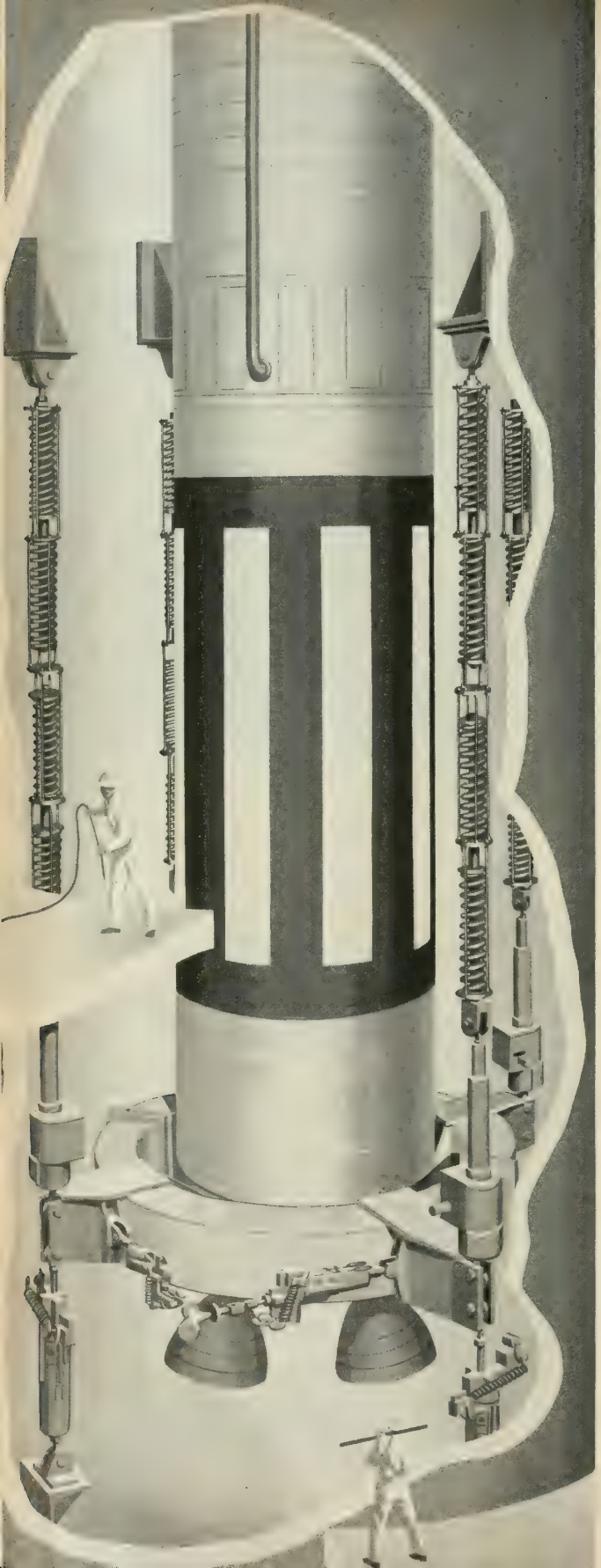
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**Guidance and controls.** To conduct study and analysis of sensors and computers.
**Systems research.** To work on systems performance optimization.
**Numerical analysis.** To develop large-scale numerical procedures for aerodynamic design and flow field analysis.
**Avionics.** To work on the design, development, and analysis of avionics systems for airborne applications.
**Reliability.** To assess the reliability and optimize the configuration and mission profiles of space systems.
**Chemical research.** To work on the development and applications of structural adhesives for aerospace vehicles.
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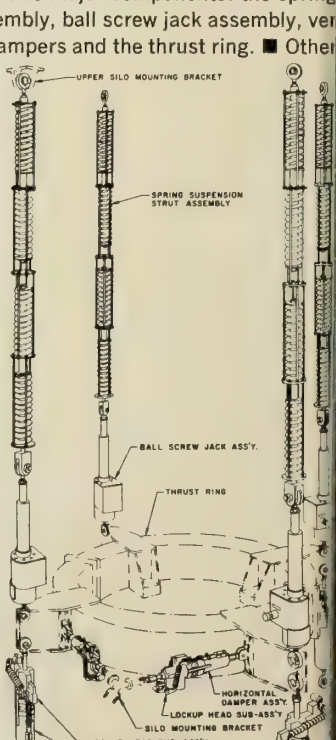
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# ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites

## Missiles

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **ALFA** (Navy) | Navy, prime; Avco, air frame | ASW surface-to-underwater; weight—500 lbs.; solid motor; conventional HE depth charge; free-flight rocket; variable range (max. about 900 yds.) | Operational; deployed on destroyers and cruisers |
| **ASROC** (Navy) | Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control | ASW surface-to-underwater; solid motor; nuclear or conventional warhead, range about 8 miles; launch weight: 1000 lbs.; unguided | Operational on destroyers, destroyer escorts, heavy cruisers and guided missile frigates. Advanced ASROC (improved Mark 44 torpedo) under development |
| **ASTOR** (Navy) | Westinghouse, prime | Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional; range, about 11 n. m.; solid | Development; to be deployed on hunter-killer submarines |
| ★**ATLAS** (Air Force) | STL, systems engineering & technical direction; GD/Astronautics, frame; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle; Acoustica, propellant utilization, propellant loading, A. D. Little Co. | ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series have inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability | Operational; 13 squadrons planned at 11 bases; already emplaced at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 54 launchers operational, ATLAS F operational; Atlas Standard Launch Vehicle-III to be developed for AF space programs |
| **BOMARC** IM-99A (Air Force) | Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion | Ramjet surface-to-air interceptor; liquid booster; 200 n. m. range; Mach 2.5; nuclear; ceiling, over 68,000 | Five bases operational in Northeastern U.S. from Virginia to Maine, production completed |
| **BOMARC** IM-99B (Air Force) | Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion | Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear; production completed | First base operational May, 1961 two more planned; A-squadrons will be strengthened with advanced B model; production completed |
| **BULLPUP** GAM-83A, ASM-N-7A (Navy-Air Force) | Martin, prime; Martin, guidance; Thiokol/Naval Propellant Plant, propulsion; Maxson, second-source prime | Air-to-surface; 3-6 mile range; radio-link command guidance (visual reference); conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and I pre-packaged liquid motor; nuclear-tipped nearly operational | Deployed with Atlantic and Pacific Fleets; operational with Air Force units. Marines tested launching BULLPUP from helicopters |
| ★**CORPORAL** (Army) | Firestone, prime; Gilfillan Bros., Inc., guidance; Ryan, propulsion | Surface-to-surface; 75 n. mi. range; weight, 11,000 lbs.; length, 45 ft.; diameter, 30 in.; liquid; nuclear; pre-set & command guidance | Deployed with U.S. & NATO troops in Europe. SERGEANT to replace CORPORAL beginning in early 1963 |
| **DAVY CROCKETT** M-388 (Army) | In-house project directed by Army Weapons Command at Rock Island, Ill. | Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers: vehicle mounted or carried by two men | Operational in Europe; FY '63 budget funds provide for procurement of majority of inventory objective |
| **ENTAC** (Army) | Nord Aviation, prime | Antitank; 6600-ft. range; 37 lbs.; solid; shaped charge HE warhead; wire-guided; man-portable | Operational; Army buying from French in quantity to replace SS-10 |
| **FABMDS** (Army) | GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies | Mobile antimissile defense system to provide an effective defense of the field army against enemy ballistic missiles | Feasibility studies submitted to ARGMA last year; evaluated by experts; future in doubt due to DOD dissatisfaction |
| ★**FALCON** GAR-1, 1D, 2, 2A, 3A, 4A, 9, 11 (Air Force) | Hughes, prime; Hughes, guidance; Thiokol, propulsion; Lockheed Propulsion, GAR-9 propulsion | Air-to-air; 5 n. mi. range; supersonic; solid; conventional; 1, 1D and 3A, active radar homing guidance; 2, 2A and 4A, IR homing; GAR-11 model has nuclear warhead and hybrid IR radar homing | Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under minimum effort development |
| ★**GENIE** MB-1 (Air Force) | Douglas, prime; Aerojet-General, propulsion | Air-to-air; unguided; 6-mile range; nuclear; solid rocket; supersonic; proximity fuzing | Operational on F-101B & F-106; improved version under development |
| **HAAW** (Army) | AOMC, prime | No details; Heavy antitank/assault weapon | Development; funds in FY '63 budget |
| ★**HAWK** (Army) | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion | Surface-to-air; 22-mile range; 100-38,000 ft. ceiling; launch wt., 1275 lb.; length, 16.8 ft.; diameter, 14 in.; span, 48 in.; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles | Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); '63 procurement will essentially complete deployment objective; Marines also employing system; U.S. to sell a number of HAWKS to Israel |
| **HONEST JOHN** M-50 (Army) | Douglas/Emerson Electric, prime; Hercules, propulsion | Surface-to-surface; unguided; 12-mile range; nuclear; 5900 lbs.; ADVANCED HONEST JOHN has increased performance, lighter and smaller; also developed a lighter-weight mobile launcher and an air-transportable launcher | Operational; deployed in Europe; to be replaced by MISSILE B |

★ Indicates changes since September 1962 Astrolog

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **HOUND DOG** GAM-77 (Air Force) | North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion | Air breathing air-to-surface standoff missile; about 600 n.-mi. range; Mach 1.7; turbojet nuclear B version in production, ceiling in excess of 50,000 ft. | Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; after SKYBOLT is operational, no. of missiles on a single B-52 will be increased from two to four |
| **JUPITER** SM-78 (Air Force) | Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle | IRBM; liquid; nuclear range: over 1500 mi.; guidance: all-inertial | Operational in Italy; 2 squadrons (30 launchers) with Italian AF; one squadron also deployed in Turkey |
| ★**LACROSSE** (Army) | Martin, prime; Martin/Federal Div. ITT, guidance; Thiokol, propulsion | Surface-to-surface; mobile; command guidance; 20-mile range; solid; nuclear; weight, 2300 lbs.; length, 19 ft.; diameter, 20½ in.; wing span, 108 in. | Operational; three units in Europe; eight activated; to be replaced by MISSILE B |
| **LITTLE JOHN** (Army) | Emerson Electric, prime; Hercules Powder, propulsion | Surface-to-surface unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands | Two battalions activated in '61; each equipped with four launchers; air and helicopter transportable |
| **M72** (Army) | Hesse-Eastern Div., Flightex Fabrics, prime | Light antitank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter; range 500 yd.; replaces 3.5 in. rocket launcher and rifle grenade; earlier called LAW | Operational |
| **MACE** TM-76 A&B (Air Force) | Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; more than 650-mile range; turbojet and solid-nuclear; B model has more than 1200 mile range; inertial guidance in MACE B | Two MACE-A and one MACE-B squadron deployed with U.S. troops in West Germany; hardened facilities under construction in Germany; to be in Okinawa, Korea; replaced MATADOR in U.S. arsenal |
| **MATADOR** TM-61C (Air Force) | Martin, prime; Air Force, guidance; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; 500 mile range; speed, about 650 mph; ceiling above 35,000 ft. | Being turned over to West Germans; also deployed in Korea and on Taiwan |
| ★**MAULER** (Army) | GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; deHaviland, IR acquisition; Raytheon, radar; Burroughs, computer; FMC, vehicle | Surface-to-air; IR acquisition; solid; weight, 120 lbs.; length, 6 ft.; diameter, 5 in.; highly mobile antiaircraft and antimissile missile; tracked vehicle; 12 per launcher | Development; NATO may buy; program to be accelerated in FY '63; Navy planning SEA MAULER for landing craft |
| ★**MOBILE MEDIUM-RANGE BALLISTIC MISSILE** (Air Force) | Program Definition Phase: Hughes & Northrop, integration, assembly and checkout; Ford Aeronutronic/Fairchild Stratos & Sperry Rand, re-entry system; Thiokol, propulsion; Goodyear Aircraft, transporter-launcher-erector; Hughes and Martin in association with Sylvania Electronic Products, command and control; General Precision, guidance | Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles | State-of-art missile to be developed in shortest possible time; to be deployed in Europe and Far East. Complex political questions of control and development funding within NATO delaying program |
| ★**MINUTEMAN** SM-80 (Air Force) | STL, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle | 2nd generation ICBM; solid; deployed in hardened and dispersed silos; 32 sec. reaction time; nuclear; 3 stages; range: over 5000 miles; guidance, all-inertial; advanced MINUTEMAN with greater range-payload and new re-entry vehicle under development | Development; initial procurement late this year; to be operational mid-1962 at Malmstrom AFB; 3 squadrons at Malmstrom, Mont.; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D.; 16 squadrons through FY '63, more later; mobile version killed; advanced version to be fired from mobile command posts; expected operational 1965-66. |
| **M-55** (Army) | Norris Thermador, prime | Four-inch diameter, small, short-range rockets; for delivery of chemical agents; to be fired from 45-tube launchers | Operational both in U.S. and overseas |
| ★**MISSILE B** (Army) | Program Definition Contracts: Chrysler and Chance Vought Div., Ling-Temco-Vought | A highly-mobile general-purpose missile; range 3-30 miles; Automet guidance; one missile per launcher; nuclear or conventional warhead; storable propellants | Funds available in FY '63 budget for initial development; eventually will replace HONEST JOHN and LACROSSE; division support weapon. Contract for development probably will be awarded in November; program definition studies submitted Oct. 22 |
| **NIKE-AJAX** (Army) | Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe | Surface-to-air; 25-mile range; ceiling, 60,000 ft.; command guidance; Mach 2.5; solid and liquid; conventional | Deployed in U.S., Europe and Far East; 19 battalions still operated by National Guard are gradually being phased out |
| ★**NIKE-HERCULES** (Army) | Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe | Surface-to-air; 75-mile range; ceiling, in excess of 150,000 ft.; solid; command guidance; Mach 3+; nuclear or conventional; antiaircraft, tactical missiles; weight, 10,000 lbs. (missile & booster); length, 39 ft.; diameter, 31½ in. | Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; increasing number to be manned by Army National Guard units; more than 10 N-H batteries were deployed overseas in 1961; N-H on Taiwan |
| ★**NIKE-ZEUS** (Army) | Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe | Antimissile missile; 3-stage; 200-mile range; solid; nuclear; command guidance; weight, 22,800 lbs.; length, 48 ft.; diameter, 36 ins.; fin span, 10 ft. | Advanced development test launchings at White Sands and Pt. Mugu; complete system tests at Kwajalein against ATLAS target vehicles have begun; one successful intercept announced July 19; earlier try "not completely successful" |
| ★**PERSHING** (Army) | Martin, prime; Bendix, guidance; Thiokol, propulsion | Surface-to-surface; two-stage solid; inertial guidance; approx. 400 n. mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range | Flight test program nearing completion; to replace REDSTONE. Procurement to begin this year; W. Germany buying; first battalion activated in June |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**POLARIS** (Navy) | Lockheed, prime; GE/MIT/Hughes, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS | Underwater and surface-to-surface; solid; 1200-n.-mi. range; A-1 aboard first six submarines; nuclear; A-2 (1500 n.-mi.) aboard submarines 7-19; A-3 (2500 n.-mi.) aboard 20th and subsequent subs; possible A-4 4000-5000 mi. missile under study. Total authorized POLARIS submarine program: 35, six being added FY '63, with long-lead-time items for six more | Six subs each with 16 missiles operational. A-2 scheduled to be operational in 1962; A-3 in 1964; SSBN Hamilton—first FBM sub equipped to use TRANSIT navigational satellite—launched in August; three A-3 flight tests conducted |
| **QUAIL** GAM-72 (Air Force) | McDonnell, prime; Guidance Technology, Inc., guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment | ECM-carrying decoy; about 200 m. range; turbojet powered advanced version with 400 mile range has been flight tested | Deployed at SAC bases; carried by B-52; procurement completed FY '61 |
| ★**REDEYE** (Army) | GD/Pomona, prime; Philco, IR seeker; Atlantic Research, propulsion | Surface-to-air; 4-foot, 22-lb. bazooka-type; IR homing guidance; solid; conventional; length, 44 in.; diameter, 2.75 in.; container-launcher disposable | Development; plans for full production modified because of unsatisfactory tests; limited numbers will be procured in both FY '63 and '63; Marines also buying |
| **REDSTONE** (Army) | Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion | Surface-to-surface; liquid; 200-mile range; inertial guidance; nuclear; weight, 62,000 lbs.; length, 70 ft.; diameter, 70 in. | Deployed with U.S. troops in Europe; to be replaced by PERSHING; used in Project MERCURY suborbital flights |
| **REGULUS I** SSM-N-8 (Navy) | Ling-Temco-Vought, prime; Sperry, guidance; Aerojet-General, propulsion | Surface-to-surface; turbojet and solid; 500-n.-mi. range; speed, about 600 mph; ceiling, approx. 40,000 ft.; nuclear | Deployed aboard 5 U.S. submarines and 2 cruisers; KDU-1: drone version; modernization program initiated during FY '61 to retrofit missiles with airborne guidance; retrofit to be completed by end of FY '62 |
| ★**SERGEANT** (Army) | Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion | Surface-to-surface; solid; over 75 n. mi. range; nuclear; inertial guidance uses drag brakes in terminal phase of flight; 10,000 lbs.; 34.5 ft. long; 31 in. dia. | In production; procurement, except for training missiles, to be completed during FY '63; will replace CORPORAL; deployment in Europe in early 1963 |
| ★**SHILLELAGH** (Army) | Ford Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance | Surface-to-surface; lightweight; vehicle-mounted for use against field fortifications, armor and close-in support of troops | Development; competition with TOW may affect future of program; testing under way at White Sands |
| **SHRIKE** (Navy) | NOTS-China Lake, prime; Texas Instruments, guidance | Air-to-surface; anti-radar; guidance, passive radar homing; solid motor; formerly ARM | Development; first production buy in FY '63 budget |
| **SIDEWINDER** (GAR-8) (Navy-Air Force) | GE-Philco, prime; Philco/GE, guidance; Naval Propellant Plant, propulsion | Air-to-air; IR guidance; more than 2 m. range; conventional; new 1-C models to have switchable IR and radar-guided warheads and improved rocket motor | Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version to start early in this calendar year |
| ★**SKYBOLT** GAM-87 (Air Force) | Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle; A. V. Roe Co., Vulcan compatibility testing | ALBM; more than 1000-mile range; solid; length, 40 ft.; nuclear; to be launched from B-52 G and H and British Vulcan bombers; B-52s will carry 4 each | Development; to be bought by British; operational 1964; air drops from B-52 and Vulcan successful; 1st R&D flight partly successful; 2nd, 3rd failures; 4th, "95% successful" |
| ★**SLAM** (Air Force) | Ling-Temco-Vought, vehicles; Atomics International Div., NAA/Lawrence Radiation Labs, reactor; Marquardt, propulsion | Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph | Propulsion system being developed under project PLUTO; feasibility proven by highly successful TORY reactor tests; no firm AF requirement; Navy interested; DOD decision whether to continue due this month |
| **SPARROW III** AAM-N-6A (Navy) | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion | Air-to-air 5-8 mile range; Mach 2.5-3; ceiling, over 50,000 ft.; semi-active, CW homing, guidance; solid and pre-packaged liquid; conventional | Operational with carrier aircraft, earlier SPARROW I obsolete; production begun on advanced version (SPARROW III B) to be prime armament for F4H-1 interceptor; F3H-2 Demon also to carry III B—presently equipped with SPARROW III and III A; on Aug. 7, SPARROW III intercepted REGULUS RDU-1 drone |
| **SUBROC** (Navy) | Goodyear, prime; Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control | Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear | Operational aboard nuclear-powered attack sub Thresher; reportedly entire system was tested as part of current U.S. nuclear tests |
| **SS-10** (Army) | Nord Aviation, prime; GE, U.S. licensee | Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional | Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC |
| **SS-11** (Army) | Nord Aviation, prime; GE, U.S. licensee | Surface-to-surface; antitank; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional | Operational, to be used with airborne units and Army helicopters |
| **TALOS** (Navy) | Vitro, systems engineering; Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Sperry, guidance | Ship-to-air; 65-mile range; solid and ramjet; Mach 2.5; nuclear; radar beam riding/semi-active homing guidance | Operational aboard cruisers Galveston, Oklahoma City and three heavy cruisers; Long Beach, first nuclear-powered missile cruiser, to carry advanced TALOS |
| ★**TARTAR** (Navy) | Vitro, systems engineering; GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion | Ship-to-air; 10-mile range; Mach 2; 15 feet long and 1 foot in diameter; radar beam-riding guidance; solid dual-thrust motor; conventional | Operational; installed aboard 13 guided missile destroyers and as backup on heavy cruisers equipped with TALOS; advanced version available in 1962 |
| **TERNE** (Navy) | Kongsberg Vapenfabrikk, prime; Arma, systems integration | Surface-to-underwater ASW missile; 264 lbs; HE warhead | Navy buying from Norway to equip two destroyer escorts |
| ★**TERRIER** SAM-N-7 (Navy) | Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; ABL, propulsion | Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional; 2 advanced versions now becoming operational; also surface-to-surface capability | Operational aboard one attack carrier (Kitty Hawk), one light cruiser (Springfield) and six guided missile frigates. |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **THOR** SM-75 (Air Force) | Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle | Surface-to-surface IRBM; 1500-mile range; liquid; nuclear guidance, all inertial | Operational; 4 bases (60 launchers) in England to be closed by British |
| ★**TITAN** SM-68 (Air Force) | STL, systems engineering and technical direction; Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle | Surface-to-surface ICBM; 5000-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long; TITAN II to be used as basic core vehicle for TITAN III space booster | 8 bases for 12 squadrons planned; TITAN I squadron at Lowry AFB declared operational in April; TITAN II scheduled operational early 1963; TITAN II undergoing flight test; TITAN II will also be used for GEMINI program |
| ★**TOW** (Army) | Hughes, prime | Tube-launched, optically tracked, wire guided, HE warhead | Follow-on to ENTAC; Hughes won feasibility demonstration with a reported 8000 fps missile; may be competing with SHILLELAGH |
| ★**TYPHON** (Navy) | Bendix, GD/Pomona, missile and missile electronics; Westinghouse, weapons direction system and radar; McDonnell, propulsion | Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets; formerly called SUPER TARBasic core vehicle for TITAN III booster | Development; successor for TALOS, TARTAR and TERRIER; expense of system may delay deployment. Norton Sound is being converted; and a nuclear powered frigate is being built for the system |
| **ZUNI** (Navy) | Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion | 5-inch, air-to-surface; solid; unguided; 5 n.-mi. range conventional | Operational; designed for use on jet fighter and attack aircraft |

# Satellites and Spacecraft

| | | | |
|---|---|---|---|
| ★**ANNA** (Army, Navy, AF, NASA) | Bureau of Naval Weapons/Applied Physics Lab, prime; AF Electronics Systems Div./Edgerton, Germeshausen & Grier, flash tube experiment; Army Engineers/Cubic Corp., CW transmitter | Geodetic satellite; 600-mi. orbit; 36-in aluminum sphere (with solar cell belt, 48 in.); weighs 355 lbs.; boosted by THOR-ABLE STAR; 2 sets of xenon flash tubes produce series of 5 light flashes about 20 times a day as triangulation point; transmitter provides range determination through Doppler shift observations | Development; first launch failed May 10; second launch planned Oct. 31; future of ANNA depends on success of launch; neither Navy nor NASA appears ready to fund future program |
| **AEROS** (NASA) | No contract announced | 24-hour weather satellite earth stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster, ATLAS-AGENA or CENTAUR | Study contract award next two months. First flights would be in 1964 or 1965; development of prototype hardware, including TV cameras, to be accelerated in FY '63 |
| ★**APOLLO** (NASA) | North American, Command & Mission Modules, systems integration; MIT, guidance development; tele-communications, Collins Radio; stabilization & control, Minneapolis-Honeywell; environmental control, AiResearch; parachute recovery, Radioplane; escape tower rocket, Lockheed Propulsion Co.; Reaction controls, Marquardt; Real-time computer complex, IBM | Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN and SATURN C-1B for earth orbits; Advanced SATURN (C-5) for lunar rendezvous; NOVA for direct flight. 3-modular spacecraft: command module, 5 tons, 12 ft. high; service module, 23 tons, 23 ft. high; lunar excursion vehicle, 15 tons, 20 ft. high; total weight: 85,000 lbs. | Earth orbital shots scheduled 1964-65; lunar orbits 1966; lunar landing, 1967-68. Mission profile, lunar orbit rendezvous selected in early July; 11 firms asked to submit bids for development of lunar excursion vehicle; contract for LEM expected early this month |
| **ARENTS** (ARPA) | GD/Astronautics, prime | Series of three satellites to investigate space environment of 22,000-m. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster | Contract let to build three payloads; launchings aboard a NASA payload; program reevaluated due to CENTAUR delay. NASA pursuing almost identical program: 3 satellites, 24-hour orbit radiation probes |
| ★**AEROSPACE PLANE** (AF-NASA) | No contracts announced | Manned, hypersonic spacecraft capable of earth-to-orbit-and-return; turbofan, 0-3 Mach; ramjet, 3-8 or 10 Mach (oxygen collected and liquified during this cycle); 8 to 10 Mach-orbital speeds, $LH_2$-LOX rocket; minimum life of 100 flights reportedly a requirement; also being considered as a 5000-mile aircraft without refueling | NASA-AF ad hoc committee to prepare joint research program; report submitted; DOD funding component development program in FY '63 of $19 million; big development effort possible in FY '64; craft could be in operation by about 1970; development program estimated at $500 million |
| **BAMBI** (ARPA) | GD/Astronautics, STL | Satellite system capable of intercepting enemy missiles in boost phase using space based platforms and interceptors | Feasibility still unproved; additional research under way |
| **BOSS** (Bicastronautics Orbiting Space Station Program 698AA (AF) | Lockheed, AiResearch | Recoverable capsules with primates aboard; capable of orbital flights up to two weeks; six shots planned using ATLAS-AGENA; both circular orbits below radiation belt and elliptical orbits through the belts | Originally joint AF-NASA program; however, DOD disapproved AF participation; NASA considering funding entire $76 million program in FY '64 |
| ★**COMMUNICATION SATELLITE PROGRAM, MEDIUM-ALTITUDE** (AF-DCA-Army) | ITT, systems engineering & technical direction for DCA | Multiple-launch, active repeater comsat; 40-50 satellites in 5000-7000 mile orbits; weight, less than 150 lbs.; ATLAS-AGENA booster; narrow bandwidth, voice and teletype communications equipment | One of two systems resulting from reoriented ADVENT program; initial operational capability planned for 1964, fully operational by 1966; to use ADVENT ground stations; responsibilities: AF, satellite; DCA, interface problems; Army, ground environment |
| ★**COMMUNICATION SATELLITE PROGRAM, HIGH-ALTITUDE** (AF-DCA-Army) | ITT, systems engineering & technical direction for DCA | 24-hour, station-keeping, active repeater comsat; operational system, 3-10 satellites; weight, 500 lbs.; wide bandwidth communications equipment for encryption and anti-jamming; booster, ATLAS-AGENA | Second system evolved from ADVENT; initial capability, 1964; operational, 1966; responsibilities: same as medium-altitude system; ITT contract has hardware exclusion clause |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **DISCOVERER** (Air Force) | Lockheed, prime; GE, re-entry vehicle | THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems | Program life extended; all data on launchings classified as part of new DOD information policy; testing of AGENA D assigned to DISCOVERER program |
| ★**DYNA-SOAR (X-20)** (Air Force) | Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell guidance; RCA, communications data link. Auxiliary Power, Sundstrand. Thiokol, solid flight control motor; Goodyear, main landing gear; Bendix, nose gear. Project ASSET, McDonnell | Manned, delta-winged, 10,000-lb. boost-glide orbital spacecraft; length, 35 ft.; wingspan, 20 ft.; height, 8 ft.; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster | Development; officially redesignated X-20, but either name may be used; program reoriented and suborbital flights eliminated, design details finalized during 1961; Project ASSET will test structural integrity, using BLUE SCOUT; first DYNA-SOAR flight scheduled for 1965; air drops from B-52 likely in late 1963 or early 1964 |
| ★**ECHO** (NASA) | Langley Research Center, prime | ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital; functioning of sphere will be tested by monitoring its reflectivity to radio waves by measuring its radar cross-section | ECHO I in orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; first of two ballistic shots planned this year from AMR successful; orbital launch from PMR also planned during FY '63; suborbital flight tests to be conducted at White Sands |
| ★**GEMINI** (NASA) | McDonnell prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, Guidance System integration and computer | Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. ATLAS-launched AGENDA will be used for rendezvous missions. 15 spacecraft will be produced. Of the 12-15 missions, at least 8 will involve rendezvous and docking | Development; will be used to determine feasibility of rendezvous for lunar mission; also to test men and components for APOLLO; first unmanned flights, 1963; manned and rendezvous flights, 1964-65; AF hoping to use for training space pilots and supplying MODS |
| **LUNAR LOGISTICS VEHICLE** (NASA) | Three-month study contracts awarded to Space Technology Laboratories, Northrop Space Laboratories and Grumman Aircraft Engineering Corp. | 1500-lb. spacecraft bus to carry support payloads to the Moon; initial use on SATURN C-1B; or 20,000 lb. bus would be used with C-5; seven specific payloads will also be studied | Development expected to begin in 1963 after Congressional approval of FY '64 funds; Cost expected to run to $500 million; study contracts to be awarded in October |
| ★**MANNED ORBITING DEVELOPMENT STATION** (Air Force) | No contractors announced | 20,000 lb. manned space station for testing components and techniques in the space environment; also considered important as a source of astronaut training to provide reservoir of experienced space pilots for military missions; TITAN III-C booster | Program not approved for development, but indications DOD will approve it in FY '64 budget; AF spending approx. $6 million in FY '63 for studies; NASA also planning larger (150,000 lb.) lab for 1966-67 |
| **MANNED SATELLITE INTERCEPTOR** (Air Force) | No contracts announced | Spacecraft capable of rendezvousing, inspecting and, if necessary, neutralizing hostile satellites | Termed "absolutely essential" by the AF, program is being held up by DOD; study contracts for system to North American, Lockheed, Boeing, McDonnell, Hughes and Raytheon by SSD cancelled by DOD |
| ★**MARINER** (NASA) | JPL, prime | 450-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B 1000-lb. MARINER B also under development | Twelve shots planned. First scheduled Venus fly-by Aug. 1962 unsuccessful after booster failure; second successfully launched Aug. 27, expected to pass within 20,900 mi. of Venus early in Dec.; six MARINER B flights in 1963, two in 1964 (ATLAS-AGENDA); '64-'65 flights will use CENTAUR; soft landing on Mars in 1964 |
| ★**MERCURY** (NASA) | McDonnell, capsule | First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE | First manned orbital flight Feb. 20, 1962 by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; six-orbit flight by Walter Schirra, Oct. 3, 1962; modified MERCURY will make two 24-hour flights next year to end MERCURY program |
| ★**MIDAS, PROGRAM 239A** (Air Force) | Lockheed, prime; Aerojet IR detector system | Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; plans being finalized for early integration of advanced payloads | Development; program being re-oriented from precise orbit satellite system to ran- Raytheon by SSD cancelled by DOD dom orbit system due to technical difficulties with IR system; pushed back into development cycle. All program data classified by DOD direction |
| **NIMBUS** (NASA) | Goddard Space Flight Center, prime; GE, integration and testing; RCA, videcon cameras | 2nd generation weather satellite; Earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster | First launching scheduled for late 1963; second, six months later; four R&D satellites and four Weather Bureau satellites presently planned |
| **OAO** (NASA) | Grumman, prime; Westinghouse, electronic components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage | 3500-lb. orbiting astronomical satellite observatory equipped with 36-in. primary mirror, spectrometer; booster, SATURN C-1 | First flight scheduled in 1964; two more in 1965 |
| **OGO** (NASA) | Space Technology Laboratories, prime | 1000-lb. satellites with instruments for geophysical measurements polar (POGO) and eccentric (EGO) shots planned; can carry 50 experiments; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters | First flight scheduled in early 1964; 19 experiments planned for first shot; nine other shots planned—five in '64 and four in '65 |
| **OSO** (NASA) | Ball Brothers, prime | 440-lb. orbiting solar observatory; THOR-DELTA and ATLAS-AGENA booster, S-16 early version; S-17 and S-57 advanced versions | First flight March 7, 1962, highly successful; first flight for S-17 planned for 1963; satellite stopped sending useful data in May resumed in July as spin rate decreased; 10 more flights planned; advanced OSO studies by Ball Bros., Republic and STL |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**RANGER** (NASA) | JPL, prime; Aeronutronic, capsule; Hercules, retrorocket | 300-lb. instrument capsule with seismometer rough landed on Moon; before impact, TV camera tapes pictures of lunar surface; ATLAS-AGENA B booster | R&D; first two RANGERS failed to launch from orbit; RANGER III launched Jan. 26, failed to impact Moon, went into solar orbit; RANGER IV impacted on Moon April 26; RANGER V power went dead after launch Oct. 19, in solar orbit; five more RANGERS added to program—making a total of 14; program extended through 1964; may be extended to 20 spacecraft |
| **REBOUND** (NASA) | No contract announced | System of three rigidized multi-launched low-orbit passive communications satellites; follow-on to ECHO. Satisfactory design completed in March. ATLAS-AGENA booster | First orbital flight scheduled for 1963; experiments to be conducted jointly with Air Force |
| ★**RELAY** (NASA) | RCA, prime | 150-lb., spin-stabilized, wide-band, 700-3000 mile orbit active repeater experimental communications satellites. Spacecraft will contain two complete and separate communications transponders each capable of handling a standard TV channel or 12 two-way voice channels. DELTA booster | Britain, France, Brazil and Germany building ground stations; one launch planned in 1962; three more in 1963; advanced RELAY to receive and transmit radio and TV signals by way of 600-lb. satellite in 12,000-mi. circular orbit under study; ATLAS-AGENA booster; three launches planned for 1964; advanced version delayed until after first RELAY launch |
| **SATELLITE INSPECTOR, PROGRAM 621A** (Air Force) | RCA, prime; Hughes, detection equipment | Anti-satellite inspection system; capable of orbital plane and altitude changes to rendezvous within 50 ft. of target; to be complemented by interception system; about 2 tons; ATLAS-AGENA B launched | R&D; formerly known as SAINT; during March, 1961, contracts let to design, fabricate and test the spacecraft; program appears behind schedule since feasibility demonstration was due early this year |
| **SAMOS** (Air Force) | Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco & Northrop Ventura | Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. with E-5 capsule (3000 with E-6); ATLAS-AGENA booster; 100-300 mile circular polar orbit | Development; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; all program information classified by DOD direction |
| **SERT** (NASA) | RCA, prime | Spinning satellite carrying two electric-propulsion engines for environmental tests | SERT I to be launched last quarter 1962 with Hughes and Lewis Center engines |
| **SLOMAR** (Air Force) | Lockheed and Martin, study contracts | Logistics, maintenance, supply spacecraft for space systems | Study contracts awarded in Dec., 1960; DOD studying concepts in connection with Manned Orbiting Development Station |
| ★**SURVEYOR** (NASA) | Hughes, prime; Martin, SNAP device | 750-lb. spacecraft soft-landing 100-300 lbs. instruments on Moon; ATLAS-CENTAUR booster; also Moon orbiting vehicle planned; SNAP II nuclear power generator to be used | First Moon flights 1964; seven soft-landing vehicles planned; five lunar orbiters to transmit pictures of the surface for six months also scheduled; CENTAUR difficulties may cause payload reductions |
| **SYNCOM** (NASA) | Hughes, prime | 24-hr. orbit instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in diameter and will weigh about 55-lbs. without weight of injection motor; capable of accommodating one full duplex radio telephone channel; initial inclination to be 30 degrees | Development; three launchings using THOR-DELTA scheduled during FY '63; 500-lb. advanced SYNCOM with wide band capability (4 TV channels or 300 two-way telephone channels) to be developed in FY '63; 2 flights with ATLAS-AGENA planned for '64; 1 in '65; resembles new DOD program |
| **TELSTAR** (AT&T-NASA) | BTL, management for AT&T | 170-lb., active repeater, experimental industry communication satellite; DELTA booster. To be launched into 3000-mile orbit by NASA on cost-reimbursed basis | Development; two to four satellites planned for launch in 1962; first launch July 10 highly successful |
| ★**TIROS** (NASA-Wea. Bu.) | RCA, prime | 285-lb. meteorological satellite; TV pictures of cloud cover; TIROS II and III carried IR scanner. TIROS V dogtegged into orbit which will enable satellite to obtain data on ice-breakup in Northern hemisphere; one TIROS to be tested for effectiveness in highly elliptical orbit (3,000 mi. apogee) | R&D; first launching April, 1960; second Nov. 23, 1960; third last July 12, fourth Feb. 8, all successful; TIROS V successfully launched June 19; TIROS VI successfully launched Sept. 18; program may be expanded to allow 8 (5 NASA, 3 Weather Bureau) launches |
| ★**TRANSIT** (Navy) | Applied Physics Laboratory, prime; Martin SNAP device | Navigational satellite; R&D model over 250 lbs.; operational, 50-100 lbs.; operational system: 4 satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; THOR-ABLE-STAR booster | Operational system scheduled to be in orbit by last quarter 1962 to initially be used by POLARIS subs and greatly reduce the position errors of these subs |
| **VELA-HOTEL** (ARPA) | STL, prime; Los Alamos Scientific Lab/ Aerospace, payload | 12-sided, 300-400-lb. satellite for detection of nuclear explosions in space; 60,000-n.-mi. orbit; three satellites placed in one orbital plane with three more in a plane 90° to the first; booster, ATLAS-AGENA | Initial launchings expected during this calendar year |
| **VOYAGER** (NASA) | JPL | Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface. Capsule will then communicate with Earth through orbiting spacecraft; SATURN booster; 2400 lbs. | Study; design and development to begin this year; first flight planned by 1965; Mars orbital flight scheduled in 1966 |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**X-15** (NASA-AF-Navy) | North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Minneapolis-Honeywell, adaptive flight control electronics | Manned rocket plane; capable of 4000 mph flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 57,000 lbs. Three planes delivered; role expanded to include testing of spacecraft components and space research. Re-entry high angle of attack flights providing data for X-20 | Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #3 set new unofficial altitude record of 314,750 ft.; plane #1 set new unofficial speed record for manned powered flight of 4159 mph; X-15 will be used as trainer for X-20 |

# Space Vehicles

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|---|---|---|---|
| **AGENA** (Air Force) | Lockheed, prime; Minneapolis-Honeywell, guidance; Bell, propulsion | 1700-pound upper stage designed to go into orbit with payload; all-inertial guidance; 16,000 lbs. thrust propellants: IRFNA/UDMH; AGENA B has re-start capability. AGENA D undergoing flight tests | Used in DISCOVERER, SAMOS and MIDAS programs; used with ATLAS and THOR; 1st flight test of AGENA D in June; second, Aug. 1 |
| **BLUE SCOUT** (Air Force) | Aeronutronic, prime; Ling-Temco-Vought, Inc., frame; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion | 4-stage vehicle; speed, more than 20,000 fps; payload cap., 150 lbs. (345 mi.) orbit, 100 lbs. probe (1610 mi.); range, over 6000 mi. vert. distance; weight, 35,475 lbs. | Operational; based on NASA's SCOUT; used as space probe and small (150-lb.) satellite launch vehicle; also used as AF's Hyper-Environmental Test System |
| ☆**CENTAUR** (NASA) | GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance | High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS D booster, capable orbiting 8500 lbs.; 2300 lbs. to escape velocity and 1300 lbs. on planetary flights | Development; program responsibility transferred from MSFC to Lewis; DX priority likely; first flight test failed when $LH_2$ tank shielding broke off 54 secs. after launch; program still slipping; late 1964 or early 1965 earliest possible operational date |
| ★**DELTA** (NASA) | Douglas, booster; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ABL, propulsion | Successor to THOR-ABLE; upper stage guidance; 3 stage vehicle; 430 lb. payload capability in 500 mile orbit; 60 lbs. to escape; two new versions—DSV-3A and DSV-3B—will have 700 and 800 lbs. payload capability, respectively | Launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA; DSV-3A used for EXPLORER XIV; DSV-3B to become operational early 1963 |
| ★**NOVA** (NASA) | General Dynamics/Astronautics and Martin awarded design study contracts; Martin, launch facilities study | 1st Stage: 8-12 F-1 engines; 2nd Stage: 2 or more M-1 engines; 3rd Stage: 1 J-2 engine; Payloads: 240-350 tons in 345 mile orbit; 75 tons to escape; 50 tons planetary probe (liquid) | R&D on 1.5 million lb. F-1 engines; solid first stage may be developed later; alternative to advanced SATURN (Rendezvous) and ROVER nuclear rocket; operational target date 1970 |
| ★**ORION** (Air Force) | General Atomic | Space booster propelled by series of atomic explosions to lift 1000 tons into orbit | Studies; program may be in trouble because of AF difficulties in justifying it; feasibility proven using HE charges in Project PUT-PUT series |
| **ROVER** (NASA, AEC) | Lockheed, vehicle prime; Aerojet, NERVA prime; Westinghouse, propulsion | First nuclear rocket: KIWI B | First Rover flight test expected 1966-67; operation vehicle 1968-69; to be compatible with both ADVANCED SATURN and NOVA launch vehicles; reactor for NERVA engines to be selected by end of the year |
| **SATURN C-1** (NASA) | Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas | 2-stage vehicle for early orbital tests of APOLLO and various space programs. 1st stage: 8 Rocketdyne H-1 engines using LOX/RP; 2nd stage: 6 Pratt & Whitney RL10-A3 engines using LOX/$H_2$; 20,000 lbs. into 345-mi. orbit | First C-1 launching Oct. 27, 1961 from Cape successful; second April 24, 1962; both flights with inert upper stage; first flight with live upper stages 1963; S-IV stage successfully static-tested by Douglas in August |
| **SATURN C1-B** (NASA) | Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas | S-1: 8 H-1, LOX/RP engines total thrust 1.5 million lbs.; S-IVB: 1 J-2 LOX/$LH_2$ engine with 200,000 lbs. thrust; payload capability, 30,000 lbs. in 345-mi. orbit | Development; first flight 1964 or early 1965; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; may also be used as a supply vehicle |
| **SATURN C-5** (Advanced Saturn) (NASA) | Systems engineering, assembly and guidance, Marshall Center; S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American | S-1B: 5 F-1 engines; S-II: 5 J-2 engines; S-IVB: J-2 engine; 1st stage: LOX/RP; Upper stages, LOX/$H_2$; 100 ton payload in 345 miles orbit; 43 tons to escape velocity; 30 tons, planetary missions | R&D; first flight scheduled for 1965; prime booster for APOLLO missions; will also be used to boost Orbiting Space Station |
| ★**SCOUT** (NASA) | Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion | Solid four-stage satellite launcher; 150 lb. payload in 345 n.-mi. orbit; also, used as space probe vehicle | SCOUT flights in '61 completed R&D; payload being increased to 250 lbs.; improved 1st stage successfully tested |
| **THOR-ABLE-STAR** (Air Force-NASA) | STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion | Three-stage vehicle, orbital capability about 900 lbs. in 300 mi. orbit; upper stage has restart engines | THOR-ABLE phased out. Used in TRANSIT, ANNA, COURIER, and COMPOSITE satellite programs |
| ★**TITAN III** (Air Force) | Martin, systems, integration; United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Martin, standardized upper stage; AC Spark Plug, guidance | Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle to be developed; modified TITAN II guidance | Development; first flight May '64 (T-IIIA); Jan. '65 (T-IIIC); 17 development flights planned (12 TITAN II core vehicles (A version), 5 full TITAN III's (C version)); development program to cost $808 million; prime booster for military, and some NASA missions, for next 10 years; operational in 1965; up to 30 launches a year foreseen |

# Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. orbits Earth; perigee 337 km, apogee 1710 km, period 105.5 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits Earth; perigee 622 km, apogee 3972 km, period 133.9; transmitting 108.024 mc.

**LUNIK I "MECHTA"** (3245 lbs.) Russia. Launched 1/2/59. In orbit around Sun on 450 day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits Earth but is "wobbling"; perigee 558 km, apogee 3292 km, period 125.3; not transmitting.

**PIONEER IV** (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun on 398 day cycle; apogee 1.142 au, perigee 0.9871 au; achieved primary mission—Earth-Moon trajectory; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits Earth; perigee 529 km, apogee 3701 km, period 129.7; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits Earth; perigee 549 km, apogee 1078 km, period 101.1; not transmitting.

**PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun on 311.6 day period; interplanetary environment probe; aphelion .9951 au, perihelion .8061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits Earth; picture-taking weather satellite; perigee 678 km, apogee 763 km, period 99.1; not transmitting.

★**TRANSIT 1B** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits Earth; perigee 359 km, apogee 628 km, period 94.4. First R&D navigation satellite. Not transmitting.

★**MIDAS II** (5000 lbs.). U.S. Launched 5/24/60, est. life 8-15 years. Orbits Earth; perigee 470 km, apogee 506 km, period 94.2. Telemetry for IR scanning failed two days after launch. Not transmitting.

★**TRANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits Earth, perigee 609 km, apogee 1062 km, period 101.6. Not transmitting.

★**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits Earth; perigee 605 km, apogee 1064 km, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits Earth; perigee 1008 km, apogee 1963 km, period 115.6. First successful orbiting of passive communication satellite.

★**COURIER 1B** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits Earth; perigee 980 km, apogee 1199 km, period 106.9. First Successful launching of delayed active repeater satellite. Not transmitting.

**EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits Earth; perigee 416 km, apogee 2261 km, period 112.4. Provided ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits Earth; perigee 617 km, apogee 733 km, period 98.2. Not transmitting.

★**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits Earth; perigee 476 km, apogee 541 km, period 94.8. First R&D reconnaissance satellite.

**VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61. Orbits Sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits Earth; perigee 692 km, apogee 2470 km, period 117.6. A 12-ft. "polka dot" balloon.

**EXPLORER X** (78 lbs.) U.S. Launched 3/25/61. Optical pumping magnetometer. Position uncertain.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits Earth; perigee 487 km, apogee 1779 km, period 107.8. Measures gamma rays from the stars absorbed in Earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits Earth; TRANSIT—perigee 873 km, apogee 1006 km, period 103.8. GREB-INJUN—perigee 878 km, apogee 1001 km, period 103.8. Transmitting. IVA: 54; 150; 324; 400. GREB-INJUN: 136.5. GREB III and INJUN failed to separate.

★**TIROS III** (285 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 740 km, apogee 816 km, period 100.3. Transmitting cloud cover pictures.

★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits Earth; perigee 3374 km, apogee 3516 km, period 161.5. IR early warning satellite.

**EXPLORER XII** (83 lbs.) U.S. Launched 8/16/61. Insufficient observations. Study Van Allen belts and energetic particles in space.

★**MIDAS IV** (3500 lbs.) U.S. Launched 10/21/61. Orbits Earth; perigee 3481 km, apogee 3771 km, period 166.0. IR scanning early-warning satellite.

★**DISCOVERER XXXIV** (2100 lbs.) U.S. Launched 11/5/61. Orbits Earth; perigee 215 km, apogee 509 km, period 91.9. Malfunction in orbit forced abandonment of usual attempt to recover capsule.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits Earth; perigee 916 km, apogee 1127 km, period 105.6. Satellite is an operational prototype of the Navy's navigational satellite. Solar cells damaged by radiation from U.S. July 9 nuclear test.

★**TRAAC** (200 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits Earth; perigee, 970 km, apogee 1094 km, period 105.6. Designed to test new system of stabilization based on the Earth's gravitation field. Also designed to supply data on the Van Allen belt. Solar cells damaged by radiation from U.S. July 9 nuclear test.

**RANGER III** (727 lbs.) U.S. Launched 1/26/62. Orbits sun on 406.4 day cycle; probe failed to impact, went into heliocentric orbit; aphelion 1.163 au., perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits Earth; apogee 846 km, perigee 707 km, period 100.3; weather satellite to gather cloud cover pictures and IR heat balance data. Transmitting 136.23; 136.92 mc.

★**ORBITING SOLAR OBSERVATORY** (440 lbs.) U.S. Launched 3/7/62. Orbits Earth; perigee 551 km, apogee 588 km, period 95.9; payload consisted of 13 experiments to study solar radiations, investigate dust particles in space and thermal radiation characteristics of spacecraft surface materials. Resumed transmitting on 136.744 mc. in latter part of June after stabilization lapse on May 22.

★**COSMOS II** (?) Russia. Launched 4/6/62. Orbits Earth; perigee 194 km; apogee 1212 km, period 98.8; second in a series of space environmental research satellites; transmission data not known.

★**COSMOS III** Russia. Launched 4/24/62. Orbits Earth; perigee 193 km, apogee 285 km, period 89.2; third of a series and intended to study weather, communications and effects of radiation on man during prolonged space flights.

★**ARIEL: INTERNATIONAL SATELLITE** (132 lbs.) U.S-U.K. Launched 4/26/62; perigee 396 km, apogee 1198 km, period 100.8; first joint satellite (U.K. built payload; U.S. supplied booster, satellite structure and tracking facilities) to study the ionosphere and the intensity of cosmic radiation. Solar cells damaged by radiation from U.S. July 9 nuclear test. Transmitting 136.408 mc.

★**COSMOS V** (?) Russia. Launched 5/28/62. Orbits Earth; perigee 209 km, apogee 1250 km, period 99.3; another Soviet satellite for space environmental research. Transmitting.

★**TIROS V** (285 lbs.) Launched 6/19/62. Orbits Earth; perigee 603 km, apogee 960 km, period 100.5. IR components & one TV camera not functioning but satellite still expected to provide data on the breakup of ice in northern latitudes as well as on the growth of hurricanes. Transmitting 136.235; 136.922 mc.

★**TELSTAR I** (170 lbs.) Launched 7/10/62. Orbits Earth; perigee 949 km, apogee 5643 km, period 157.7. AT&T-developed experimental, active repeater communications satellite to study feasibility of low-altitude system and measure the effects of radiation on satellite systems and lifetime; successfully transmitted transatlantic TV, telephone and radio traffic. Transmitting 136.05 mc.

★**COSMOS VIII** (?) Launched 8/18/62. Orbits Earth; perigee 256 km, apogee 561 km, period 92.7. Part of space research program.

**MARINER II** (447 lbs.) Launched 8/27/62. Heliocentric orbit. Planetary spacecraft expected to come within 20,900 mi. of Venus Dec. 14. Carrying microwave radiometer and IR radiometer to determine temperature and atmospheric conditions on Venus. Transmitting.

**TIROS VI** (281 lbs.) Launched 9/18/62. Orbits Earth; perigee 681 km; apogee 716 km, period 98.7. With the partially disabled TIROS V, this weather satellite gives the U.S. two active vehicles for weather observations. Transmitting 136.235; 136.922 mcs.

**ALOUETTE** (300 lbs.) Launched 9/29/62. Orbits Earth; perigee 1004 km, apogee 1029 km, period 105.5. Polar-orbiting topside sounder to investigate upper levels of ionosphere and space noise. Satellite built by Canada; launched by U.S. Transmitting 136.979 mcs.

**EXPLORER XIV** (89 lbs.) Launched 10/2/62. Orbits Earth; perigee 281 km, apogee 98,533 km, period 2185. Designed to study charged particles, solar phenomena and magnetic fields. Transmitting 136.44 mcs.

**COSMOS IX** (?) Russia. Launched 9/27/62. Orbits Earth; perigee 299 km, apogee 352 km, period 90. Transmitting 19.994 mcs.

**COSMOS X** (?) Russia. Launched 10/17/62. Orbits Earth; perigee 192 km, apogee 376 km, period 90.2. Transmitting.

**COSMOS XI** (?) Russia. Launched 10/20/62. Orbits Earth; perigee 243 km, apogee 915 km, period 96.1.

**EXPLORER XV** (98 lbs.) Launched 10/27/62. Orbits Earth; perigee 358.73 km; apogee 20,299.29 km; period 315.5 min. Partially successful attempt to study man-made radiation

**SECRET AF SATELLITES:**

- Launched 3/7/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 235 km, apogee 543 km, period 92.4.
- Launched 4/9/62. wt. unk. ATLAS-AGENA B. Orbits Earth; perigee 2821 km, apogee 3373 km, period 153.0.
- Launched 8/23/62. wt. unk. BLUE SCOUT. Orbits Earth; perigee 612 km, apogee 861 km, period 98.6.
- Launched 9/1/62. wt. unk. ATLAS-AGENA. Orbits Earth; perigee 292 km, apogee 669 km, period 94.3.
- Launched 9/17/62. wt. unk. ATLAS-AGENA. Orbits Earth; perigee 201 km, apogee 558, period 92.2.
- Launched 9/29/62. wt. unk. BLUE SCOUT. Orbits Earth; perigee 197 km, apogee 258 km, period 89.1.
- 10/9/62. wt. unk. THOR-AGENA. Orbits Earth; perigee 166 km, apogee 469 km, period 90.9.




# ENGINEERS

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*Further information, including details of current requirements, is on the next page. For a prompt, confidential reply to your inquiry, use the attached form or write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Department 130-90, General Dynamics | Astronautics 5776 Kearny Villa Road, San Diego 12, California.*

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## ELECTRONIC ENGINEERING

BS or MSEE with applicable experience required for assignments in telemetry, radiation systems, trajectory measurement, tracking, guidance, automatic controls, packaging, instrumentation, digital devices, printed circuitry, logic design, component and systems testing or measurement systems. Openings exist in design, development, reliability, vendor qualification selection, and test on ground and airborne electronic components, subsystems and systems.

## DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

**STABILITY AND CONTROL:** to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamic behavior of space boosters.

**STRUCTURAL DYNAMICS:** to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plant, instrumentation requirements, scaling factors, etc.

## AEROTHERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

## ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignment in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

## FLIGHT MECHANICS

Analytically talented graduate engineers at all levels required for staffing of new Flight Mechanics Development Section. Programs include aerospace vehicle guidance and automatic control, aeroelasticity, and aerophysics. Responsibilities of the Section also involve technical analyses and simulation work in support of all space vehicle programs at Astronautics.

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Openings exist in failure analysis, testing and reliability analysis of existing systems. BS in Engineering required with experience in systems or component test or in analysis of behavior and performance of mechanical or electronic systems.

## MECHANICAL DESIGN

Mechanical Engineers with design experience in structures or pneumatic and hydraulic systems, are required for weapons and space systems design. Experience in design for extreme environmental conditions, or for cryogenic fluids including liquid hydrogen is highly desirable. BS in AE, ME or CE required.

## TECHNICAL WRITING

Technical Writers with some college and/or formal technical training and experience in technical publications are required for assignments involving technical reports, technical manuals, manual subcontractor control, manual change control, technical manual verification or proposal writing.

*If the inquiry card has been removed, or if you wish to furnish or request more detailed information please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5776 Kearny Villa Road, San Diego 12, Calif.*

GD

**GENERAL DYNAMICS | ASTRONAUTICS**

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# Technical Countdown

## ELECTRONICS

### Highly Efficient Laser Developed by GE

A new type of laser that generates coherent light directly by passing an electric current through a semiconductor crystal will lead to the marketing of two experimental gallium-arsenide light sources by General Electric. Perfected by Dr. Robert N. Hall of GE's Research Laboratory, the laser does not require pumping by an auxiliary process. Excitation is achieved directly by injecting electrons and holes into the plane of the junction region in the middle of a tiny gallium-arsenide diode. The directional and coherent beam of infrared light is emitted from the junction-plane edges at two carefully polished and precisely parallel sides of the device. Achievement of laser action is attributed to a combination of improved control of impurities in the crystals and the concept of an optical cavity with parallel reflecting surfaces in which coherent light build-up occurs. In his early experiments, Hall has observed that at least half of all the light generated is coherent, making the new laser far more efficient than gas or crystal lasers that generally convert less than 1% of the pumping light into a coherent beam.

### Thermal Mapping Cuts Circuit Test Costs

A method of thermal mapping that eliminates the need for much of the costly life-testing currently done on microelectronic circuits will be marketed by Philco's Lansdale Div. Current methods amount to no more than a temperature profile and involve extensive computer time. Philco uses a direct, rapid and non-destructive infrared scanning process, useful down to 50°C with a resolution of 1.4 mils. The temperature profile is not affected by the measurement. The temperature stability of microcircuits under any bias condition can be accurately predicted through a simple correlation of temperature profiles with storage life tests, reducing the need for operating life testing.

### Re-entry Splash Point Can Be Pinpointed

A radio-location system combining the Loran-C navigation system with microwave tracking is being proposed by Sperry Gyroscope Co. engineers to pinpoint re-entry vehicle splash points within a ship's length. The system could be operated with four tracking ships equipped to receive radio signals from both land-based Loran-C transmitters and the satellite itself. Each ship can determine its exact location through the Loran signals; this, combined with the time of arrival of successive satellite signals, would be radioed to a recovery center. A computer would then calculate successive satellite positions, establish a predicted trajectory and point of impact. Atomic clocks would be used for the timing input. Successful tests have already been run on the AMR to synchronize current clocks within fractional microseconds.

### Re-Entry Sheath May Be Useful

Electrical power may be obtained from the ionized shock layer on a re-entering spacecraft, using an on-board inductive magnetohydrodynamic generator. North American Aviation's Dr. John R. Radbill indicated as much as 200 kilowatts could be generated in this manner. The expert told a Manned Lifting Planetary Entry Symposium in Philadelphia last week that the power could be used to transmit TV over interplanetary distances.

### Molecular Electronic Airborne Computer Readied

The first lightweight, general-purpose airborne digital computer to use molecular electronics will soon be in production at AC Spark Plug Div., General Motors Corp. Dubbed MAGIC, the unit will handle computations and actuate vehicle controllers for guidance and control of missiles, space vehicles or aircraft. Micrologic units from Fairchild Semiconductor are used in the logic organization of the computer, each element replacing about eight resistors and transistors. The production model will weigh about 34 lbs. and be roughly the size of a 15-in. portable TV set.

## ADVANCED MATERIALS

### Hydrocarbons Eliminated from Vacuum Systems

An extensive project carried out by National Research Corp. shows hydrocarbon contamination can be eliminated from the oil diffusion pumps in ultra-high-vacuum systems through proper baffling and operating techniques. Although it has often been thought that the primary culprit was the pumps themselves, because of the presence of oil, NRC researchers found that in many cases the real villains were the rubber sealing gaskets and inadequate cleaning procedures. Test runs consisted of placing clean steel samples in vacuum chambers for 150 hrs, or less at $10^{-9}$ torr ranges. A drop of distilled water spreading over the entire surface indicated the absence of even a monomolecular layer of hydrocarbons.

### Potassium Nitrate For Computer Elements

Scientists at General Motors Research Labs are investigating the possibility of using cheap and abundant potassium nitrate for computer and amplifier elements. The material has nearly ideal electrical characteristics—including apparent true "coercivity" at room temperatures, under certain conditions. Current research is concentrating on determining the factors affecting the stability of the ferroelectric form of the nitrate at ordinary temperatures.

### Zeolite For Fuel Cells?

Electrolytes made of a synthetic zeolite membrane are being explored by scientists at Astropower, Inc., subsidiary of Douglas Aircraft Co., as a substitute for the more conventional liquid or organic ion-exchange electrolyte materials. The membrane will be compressed between two thin metallic layers, the electrodes of the sandwich. The NASA-funded study calls for each wafer design to be tested for hydrogen ion exchange capacity, water absorption equilibrium, electrical conductivity, chemical stability, diffusion and porosity. Such wafers should operate in many different fuels and oxidizers, resist high radiation levels, minimize corrosion and pressure problems and perform efficiently under zero-g conditions.

### Haynes Cb-Alloy Profiled

An extensive properties profile is offered by Haynes Stellite on its Cb-752, a high-strength, fabricable columbium-based alloy in the running for such programs as *Asset, Apollo* and *Dyna-Soar (X-20)*. The alloy has a yield strength over 18,000 psi at 2400°F and is machinable by conventional methods. Last week, Haynes displayed a 0.016-in.-thick sheet, 40 in. long and 100 in. wide, at the 1962 Metals Show in New York City.

# SNAP Safety Tests Slated for Orbit

***Agena to carry re-entry package for tests of nuclear-core burn-up characteristics***

**by Frank G. McGuire**



*TAPE RECORDER (right) and FM/FM telemetry unit re-entered in titanium canister, which secured temperature data via external transducers in same path as samples.*

AT LEAST FOUR *SNAP* devices will be orbited by the Air Force Special Weapons Center beginning next year in safety tests to investigate the burn-up characteristics of nuclear power packages during re-entry. Two *SNAP-2* and two *SNAP-10A* units will be used in the upcoming "Snapshot" phase of the program.

Completion of the joint Atomic Energy Commission/Air Force tests will hasten AF use of completely operational nuclear power units on its *MIDAS* and *SAMOS* satellite systems. The *SNAP-10A* units, using a thermoelectric system, are expected to provide 224,000 kilowatt hours of power for equipment aboard the Air Force's two highest-priority satellites.

Lifetime of the unit is expected to be at least one year of 500-watt performance, using a modified *SNAP-2* reactor. Designed to operate mostly on a static basis, *SNAP-10A* will use a thermoelectric generator for power conversion, and will require no control equipment after orbital start-up.

Shielding for the electronics and other portions of the satellite payloads will boost the system's unshielded weight of 525 lbs. to about 750 lbs.

Ballistic tests flown aboard *Atlas E* ICBM's from Cape Canaveral carried instrumented pods downrange with eight simulated cores each. Cores were destroyed upon re-entry to gain data on the materials and designs involved. These tests ended last August.

In the orbital Snapshot tests, the payloads again will be deliberately burned up upon re-entry to gain further data on the same problems, as well as to check out the correlation between theoretical and experimental data.

Maj. Herman W. Baker, chief of the Nuclear Power Div., said AFSWC is running the tests as part of its responsibility for operational use of nuclear power for AF programs, including tying of basic packages to specific uses.

Although the Snapshot program is largely classified, it has been announced that the 750-lb. *SNAP-10A* system, capable of generating 500 watts of electrical power, would fit ideally into Air Force satellite programs such as *MIDAS* and *SAMOS*. An AEC statement said the nuclear-powered versions of the AF satellites were due for flight tests early in 1963.

The *Atlas-Agena-B* vehicles will go into polar orbit from Pt. Arguello, Calif., to provide early operational experience with the nuclear power supplies under conditions closely approximating the ultimate *MIDAS/SAMOS* missions.

The ballistic tests from Cape Canaveral contained no radioactive material, but the Snapshot series presumably will have operating systems aboard.

Initial flights in the safety program began July 31, 1961, when an *Atlas* took a 100-lb. pod of materials down the Atlantic Missile Range. Succeeding shots resulted in three successes in five launch attempts.

• **Ballistic flight details**—In the last four ballistic flights, a 500-lb. pod was carried on each missile and ejected to descend on a separate trajectory. The pod, containing eight simulated cores in four different configurations, scattered various packages along its trajectory.

Re-entry heat, estimated to be about 10% of that encountered during orbital re-entry, ablated the materials in the test articles and released flare material inside. Ignition of the flare material was photographed by aircraft equipped with batteries of spectrophotometric cameras and data obtained from which it can be determined when operational *SNAP* devices would burn up.

The telemetry capsule sent heating information back to ground stations for use in confirming environmental conditions, while the flare-loaded material samples gradually melted and disintegrated. Samples of cesium, rubidium, potassium, and sodium were used in both spherical and cylindrical form. Melting points were preciscely calculated by coordinating data gained from cameras, ground radar centers that established precise aircraft position, and timing techniques.

A star background was also photographed to provide additional position verification.

• **Disintegration critical** — Maj. Philip McMullen, project engineer, said AFSWC is evaluating a number of additives to ensure the complete disintegration of nuclear cores upon re-entry. The additives would increase the emissivity and decrease the viscosity of the materials.

The pod consists of channels into which the material samples are placed against a spring-loaded ejection device operated by programing equipment. The telemetry capsule, located in the center channel, is similarly ejected and follows the other packages down. The first flight in the program was principally to test operation of the telemetry capsule to ensure that later tests would not be jeopardized by its faulty operation. Samples of sodium and potassium were also included to check the flare technique.

Non-nuclear components of *SNAP* systems are due to be flight-tested in a similar manner, as are complete radioisotopic generators.

Experiments have thus far given AFSWC a firm correlation between theoretical and performance information, and confidence in ability to predict configurations has been considerably increased.

Other studies by AFSWC's Nuclear Power Div. include attempts to derive a model that will describe the formation and ablation of layers of molten material on and from the surface of a re-entering fuel element. Theoretical analysis and experiments are being used to formulate the model, which will include parameters such as aerodynamic forces, inertial forces, and thermodynamic conditions.

Analysis of the hazards of nuclear power devices will include determination of atmospheric diffusion characteristics of various particle sizes simulating debris from a destructive burn-up of a re-entering reactor.



*SIMULATED CORES of varying shapes and wall thicknesses were ejected from four outer channels of pod after telemetry can ejected from center channel in testing.*

• **Other studies** — In addition to straightforward re-entry studies, the Nuclear Power Div. is studying methods other than re-entry to remove a reactor from Earth orbit.

NPD has a program under way to develop handling equipment for all AF *SNAP* devices and nuclear propulsion systems. Advent of the nuclear systems has brought about increased emphasis on methods of handling routine servicing and emergency handling of nuclear components.

Although remote manipulating devices are common in laboratories, NPD points out that very little work has been done in the fields of mobile remote manipulation devices capable of moving over unprepared terrain, handling heavy loads or performing emergency recovery or rescue operations.

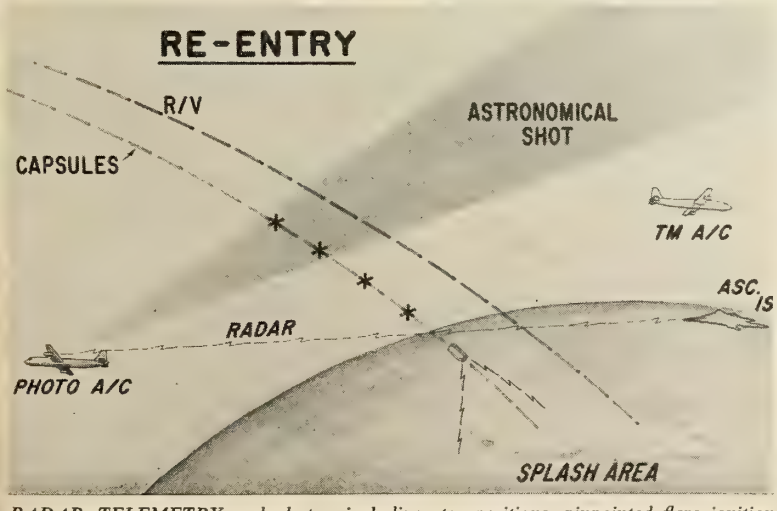
A primary safety consideration is that power units containing reactors are designed so that the reactor cannot become critical until an orbit of several hundreds of years has been established.

Ground safety tests of *SNAP* devices have included fire tests where 14,500 lbs. of kerosene, aniline and nitric acid were ignited over a simulated missile structure holding five nuclear generator assemblies. After a 15-min. fire where peak temperatures reached more than 5000°F, no detrimental effects were noted.

Explosion tests using 1650 lbs. of TNT were conducted on *SNAP* units made of Haynes 25 alloy and various grades of aluminum, subjecting the devices to shock pressures of 1000 psi. AEC technicians said even the lowest grade aluminum core retained its mechanical integrity.

Impact tests used two complete generators and one bare fuel capsule. Maximum velocity was obtained by firing the specimens against a granite block. The preheated bare fuel capsule was deformed but did not rupture on impact.

Still not satisfied, AEC ran test specimens through plasma arc tunnels for simulated re-entry tests. The complete generator and fuel core subjects substantiated that *SNAP* devices would burn up to micron-sized particles upon re-entry, and disperse completely. ⌗




*RADAR, TELEMETRY and photos, including star positions, pinpointed flare ignition times and altitudes as a total of 32 simulated cores burned up upon re-entry.*

# OCF Sets Up New Defense/Space Group

***Division will guide government contract activities, expected to increase, while protecting know-how***

**by John F. Judge**

OWENS-CORNING Fiberglas Corp. is establishing a new corporate division to meet the intricate demands of the defense/space market in glass fibers and allied technologies.

In announcing the move, OCF President Harold Boeschenstein told M/R the new division will have all the corporate backing required to perform its function adequately.

Managed by Vice President Reeve K. Biggers, the new Aerospace Div. will guide research, development and marketing activities in specialized military/space fields.

Initial staffing will be low, as the division seeks to define its areas of operation through discussions with NASA, the military and prime contractors. Biggers intends to keep the group small and flexible while taking maximum advantage of OCF's talents and facilities.

Dr. Jesse Plummer will head the technical staff and E. M. Lindsay will manage laboratory operations. Supporting personnel are being gathered both from OCF and outside the firm.

• **More government contracts**—The division will take over all current government contracts and other related activities in progress at OCF. Biggers anticipates an increase in this area as the firm's research and development activity becomes more closely tuned to military/space problems.

But OCF still intends to protect its investment in glass technology and its position in an extremely competitive commercial market by exercising care in future government contracts.

Glass fiber technology is still largely an art, even though OCF has built an extensive research capability. This know-how is what the firm seeks to protect. A commercially oriented firm such as OCF regards its contribution to the solution of NASA and defense problems as an increment made possible—and supported—by the whole spectrum of glass technology acquired over decades.

Glass in the form of fiber-reinforced plastics has solved several difficult problems in the missile field. One example is filament-wound solid-rocket motor cases, where both dollar and weight savings have been effected.

But glass producers have been criticized by fabricators for not devoting sufficient effort to the many problems in the volume-limited defense and space areas, and concentrating on the highly lucrative commercial markets. The OCF development should significantly alleviate this situation.

• **Other glass research** — Filament winding is not the only area of interest to OCF (M/R, April 16, p. 24). Biggers says research is in progress on high-temperature crystal fibers to replace or supplement materials now available for high-temperature applications.

Other development projects include studies of cellular glass pellets, glass flake, high-tensile-strength glass, low-dielectric glass and glass-metallic fibers.

The pellets combine light weight with unusually low conductivity and a melting point of 1700°F. The flake is a reinforcing material that can provide improved stiffness and thermal properties for composite structures—with extremely low permeability.

Metal-coated fibers or glass fibers with metal cores may find their way into electronic and electromagnetic applications.

While the division expects to keep potential customers aware of these developments, it also must keep OCF abreast of the problem areas. These are so varied and changing almost day-to-day that OCF found itself unable to cope with them without a major line organization such as the new division. ⌘




## *Biggest Case Ever Shipped Overland En Route to ARS*

*MASSIVE 156-in.-dia. rocket engine case built by Hercules Powder Company is shown during early stages of cross-country trucking from New Jersey to the American Rocket Society's Seventeenth Annual Meeting and Space Flight Exposition, to be held in Los Angeles Nov. 13-18. The case, over 25 ft. long, contains 240 million miles of glass threads and is the largest yet made by the filament-winding process. If it completes its journey, the 20,000-lb. Hercules case will be the first of such size to make the arduous coast-to-coast overland trip. The chamber is designed for 1200 psi minimum burst with composite hoop stress of 85,000 psi. Steel polar fittings—used to cut cost and expedite delivery—account for 27% of the weight. A combination of helical and 90° windings was used during fabrication at Hercules' Rocky Hill, N.J. plant to provide the required longitudinal-to-girth strength ratio (M/R, June 25, p. 31). Winding took two weeks.*

## ARPA Pushes Hybrids

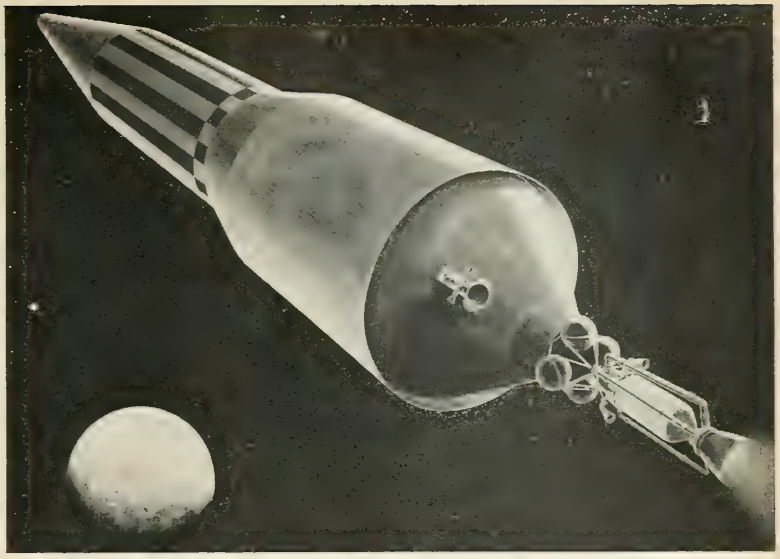
(Continued from page 14)

marked implementation of the program. In March, after evaluation of the studies conducted in 1961, ARPA held two meetings to devise a program to carry out recommendations. Decisions were made on March 28; requests for proposals were mailed within a week; ARPA committed funds to the program on June 13; the first contract was awarded by AOMC on June 28; and the other three contracts were signed by Oct. 1.

Because of the service-wide nature of the hybrid rocket potential, ARPA, rather than any of the services, undertook the initiative—even though Navy had spearheaded some of the early work. NASA, although not supporting the ARPA program with funding, is participating in exchange of information between the Defense Department programs and its own.

ARPA officials declined to cite specific chemical combinations under study, or give other details of research work. However, the agency stresses the cooperative team-effort nature of the program and the ease of information exchange. Singled out for praise, although it is not under the accelerated program, was United Technology Corp., for its work under a separate ARPA contract covering research on hybrid rocket combustion problems.

ARPA said it has set out guidelines for the industrial contractors to follow, but has tried to avoid influencing the judgment of the contractors. Under the recent contracts, quarterly progress reports are due from each firm. ⌘



**Shape of First Nuclear-powered Vehicle**

*ARTIST'S CONCEPT of RIFT (Reactor In Flight Test) stage to be built and flight-tested by Lockheed Missiles & Space Co. for NASA. First flight is due in 1966-67.*


# THERE'S ACTION IN ROCKETS AT BELL AEROSYSTEMS

With the establishment of the Bell AGENA as the workhorse of the Space Age (chalked up a record of 98.8% reliability in Air Force and NASA satellite and space probe programs), Bell is continuing to seek out new applications for advanced AGENAS. The reaction controls for the Mercury capsule were also developed at Bell, and work is now in progress on further developments in reaction controls for a variety of space programs. Additional investigations are continuing in very high energy rocket engines and in development of a multiple re-start rocket engine.

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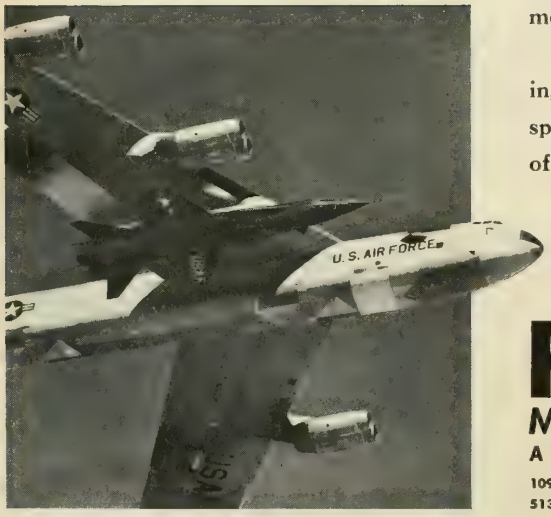



# FRUEHAUF'S VAST RESOURCES ARE KEYED TO SPACE AGE NEEDS

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Fruehauf capability played an important part in the celebrated flight of the X-15 . . . the world's first man-controlled winged space flight. Fruehauf supplied North American Aviation, working under the National Aeronautics and Space Administration, with Anhydrous Ammonia Tank Trailers for fueling the X-15 prior to take-off. Fruehauf also provided lox tanks for servicing the X-15 from the B-52 mother ship while in flight.

For additional facts on Fruehauf's capability for designing, researching, developing and producing military and space age equipment of all kinds, send for your free copy of "Fruehauf G.S.E.—Military and Missile."




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# The Industry Week

## ASPR Study Group Set Up

The new Defense Industry Advisory Council has set up a study subcommittee to investigate implementing changes in the Armed Services Procurement Regulation (ASPR). Deputy Secretary of Defense Roswell Gilpatric was chairman of the Oct. 20 executive session of the council, at which the subcommittee was set up.

Among those serving on the study group are: Westinghouse Executive Vice President E. V. Huggins, Avco President James R. Kerr and Olin Mathieson Chemical Corp.'s Board Chairman Thomas S. Nichols.

A technical working group supporting these council members will include: George Frost of General Electric, Paul Young of Philco, and Neal Hundt of American Machine & Foundry, as well as DOD representatives Graeme Bannerman, Col. William Thybony, and Kenneth Kilgore.

Other highlights of the meeting were discussions of source selection (led by Litton Industries Board Chairman C. B. Thornton), cost principles (led by Chrysler VP T. F. Morrow) and contractual incentives (led by Space Technology Laboratories President R. F. Mettler).

Next DIAC session is scheduled for January.

## Industry Facilities

Union Carbide Corp. is adding major production facilites at three sites adjacent to key rocket development centers. The facilities will be built and operated by Linde Co., a division of the firm. One of these is a liquid-oxygen/nitrogen plant to be built at a 110-acre site on the New Orleans intercoastal waterway. The two other expansions will be at Huntsville, Ala., and Deer Park, Tex. . . . *More than 700 of the 10,650 employees at General Electric's Missile and Space Div. facilities near Philadelphia will be laid off for lack of business at the company's R&D center. Layoffs will be gradual, taking place between now and the end of March 1963.* . . . In a double-barreled expansion move to accommodate customers across the country, Electronic Enclosures, Inc., has opened two new factories—one in Camden, N. J., and the other in Culver City, Calif. This is the firm's third major move—forced by growing business—over its six-year history. . . . *The 225-acre Santa Barbara, Calif., Research Park is now being shown to prospective occupants. Sites of an acre or more are offered either for sale or on a "build-to-suit-and-lease" basis. The park is part of a 4100-acre planned community being developed by the Del E. Webb Corp.* . . . Lear Siegler Inc.'s Industrial Div. has opened a modern 15-units/mo. microcircuit production facility at its industrial complex in Grand Rapids, Mich. A feature of the new operation is an LSI-developed "Multicoater," which can produce 320 half-inch-square substrates or 720 quarter-inch-square substrates during an eight-hour shift. . . . *Raytheon Co. will open a 50,000-sq.-ft. electronic components plant this month in a duty-free industrial zone at Shannon, Ireland's international airport. The operation—to be known as Industrial Components, Ireland, Ltd.—will be a wholly owned Raytheon subsidiary.*

## Trends in Industry

In a recent report on R&D in U.S. industry, the National Science Foundation says aerospace, electrical equipment and communications industries played "the predominant role in federally financed industrial R&D performance" in 1961. Foundation figures attributed $3.6 billion worth of federal R&D projects in that year to the aircraft and missiles category—a slight decline from previous years. Total industrial R&D in 1961—both federally and privately sponsored—was nearly $11 billion; it is expected to be about 4% higher this year, NSF says. . . . *The price of silver should "remain high—above $1.15 an ounce, unless the U.S. Treasury starts selling silver again," says Jack Kaplan, president of Spiral Metal Co. Kaplan's South Amboy, N.J., firm is one of the world's few smelters and refiners of industrial silver-bearing scrap. Missile/space uses of the metal have increased demands for it to the point that "industry is now using more of it than is being produced," Kaplan says.*

## Signed, Sold, Delivered

Power Designs, Inc., Westbury, N.Y., is completing negotiations for purchase of Carad Corp., Palo Alto, Calif. Both firms manufacture electronic power supplies. Purchase would double PD's volume and plant capacity and extend the firm's capabilities to include very-high-voltage units. . . . *Fairchild Camera & Instrument Corp. will acquire the Winston Research Corp., West Los Angeles. WRC, a communications R&D firm, will allow Fairchild to take over management and financial support immediately, and full take-over date is Jan. 2.* . . . In a move to expand its Florida operations, Barnes Engineering Co., Stamford, Conn., has acquired all assets of Versatronics Corp., Fort Walton Beach, Fla. Purchase—financial details of which were not disclosed—extends Barnes capabilities to provide complete systems for missile range applications. . . . *Lear Siegler, Inc., will buy 40,000 shares of Astek Instrument Corp. stock by Nov. 15, with options for later purchase of another 20,000 shares. Astek says the deal will produce new capital for expansion. LSI has been represented on Astek's board since last April.*

# AWARDS

## AIR FORCE

$20,992,000—**General Electric Co.,** Philadelphia, for additional work on space programs (2 contracts).

$20,838,040—**Thiokol Chemical Corp.,** Brigham City Utah, for *Stage 1 Minuteman* motors.

$5,446,533—**Mitre Corp.,** Bedford Mass., for systems engineering for command and control systems.

$5,000,000—**American Machine & Foundry Co.,** Greenwich, Conn., for the re-installation and check-out of the *Titan* ICBM launcher at the 4C-1 complex at Beale Air Force Base, Calif.

$4,500,000—**Martin Marietta Corp.,** New York City, for continued research and development of a space program launch vehicle program (supplemental contract). Work to be done at Baltimore.

$3,020,000—**General Dynamics/Astronautics,** Los Angeles, for an *Atlas* standardized space launch vehicle (SLV).

$2,820,000—**General Dynamics Corp.,** New York City, for work on *Atlas* missiles at Vandenberg Air Force Base, Calif. and Cape Canaveral.

$2,500,000—**American Machine & Foundry Co.,** New York City, for work on the *Titan I* facilities at Beale Air Force Base, Calif.

$1,454,000—**United Technology Corp.,** Sunnyvale, Calif., for work on rocket motors.

$40,765—**Boeing Co.,** Seattle, Wash., for assembly of *Minuteman* missiles and production of their parts.

## ARMY

$2,986,017—**Sperry Utah Co.,** Salt Lake City, Utah, for production of *Sergeant* missile technical manuals.

**Ford Motor Co.'s Aeronutronic Div.,** Newport Beach Calif., for a study of the reliability of the "human component" in large and complex electronic equipment and systems (undisclosed amount).

## NAVY

$5,000,000—**Westinghouse Electric Co.,** Sunnyvale, Calif. for *Polaris* missile launcher systems.

$2,800,000—**Vitro Corp's Vitro Laboratories Div.,** Silver Spring, Md., for work on shipboard surface-to-air guided missile systems (3 contracts).

$242,000—**Operations Research Inc.'s Management Systems Div.,** Santa Monica, Calif., for further implementation of the RMI system throughout the *Polaris* program for further sophistication of this reliability system.

## NASA

$319,900,000—**North American Aviation, Inc.'s Space & Information Div.,** Downey, Calif., for development and production of the second stage of the advanced *Saturn* rocket.

$1,512,731—**Welfare Process Piping Co., Inc.,** and **Grefe and Associates, Inc.,** Boise, Idaho, for fabrication and erection of a flame deflector for the *Saturn C-5* booster static test tower.

## INDUSTRY

$3,500,000—**Sylvania Electric Products, Inc.** New York City, from **Princeton University Observatory,** for development of optical and electronic equipment to be used in an *Orbiting Astronomical Observatory* satellite program directed by NASA.

$1,300,000—**Radio Corp. of America,** Camden, N.J., from **Republic Aviation Corp.,** for a data acquisition and communications subsystem for Project *Fire,* a research effort to study heat-transfer problems encountered by spacecraft re-entering the atmosphere at high speeds.

$1,250,000—**Haveg Industries, Inc.,** Wilmington, Del., from **Portland Copper and Tank Works, Inc.,** for *Stage 1 Minuteman* equipment.

$1,000,000—**Marquardt Corp.'s Ogden, Utah plant,** from **Aerojet-General Corp.'s Solid Rocket plant,** for nozzles for the first stage of the Navy's *Polaris* missiles.

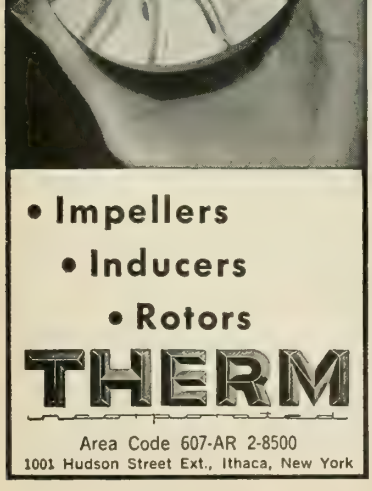
$600,000—**Radiation Inc.,** Melbourne, Fla., from **Bell Telephone Laboratories** for additional equipment for the *Nike-Zeus* antimissile missile system.

$550,000—**Pyle-National Co.,** Chicago, from **Boeing Co.,** for parts for the data-transmission system for use in *Minuteman* missiles.

$225,000—**Radio Corp. of America,** New York City, from **Boeing Co.,** for provision of spares for *Minuteman* test equipment for the assembly and checkout programs at Malstrom Air Force Base, Mont., and Vandenberg Air Force Base, Calif.

**Power Sources Div. Of Telecomputing Corp.,** Los Angeles, from **Lockheed Missiles and Space Co.,** for batteries to be used on *Polaris* missile program (undisclosed amount).

**Eagle-Picher Co.,** Joplin, Mo., from **North American Aviation, Inc.,** for batteries which will provide electric power for *Apollo* during and after re-entry (undisclosed amount).



# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Nike Zeus Project Office
Redstone Arsenal, Ala.

The *Nike-Zeus* Project Office, Army Material Command, through the New York Ordnance District proposes to award a contract supplement to Western Electric Co. for continuation for providing and firing probes to support Operation "Fishbowl". The proposed date for contract award is 11-15-62. Competitive solicitation is precluded because of the continuing nature of the development effort. This synopsis is to publicize subcontracting opportunities. All inquiries relative to subcontracting must be directed to Western Electric Co., Inc., 222 Broadway, New York 38, N.Y.

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Bureau of Naval Weapons
Washington 25, D. C.

For information purposes only. Bureau of Naval Weapons contemplates award of a contract to General Electric Co., Pittsfield, Mass., for field engineering services in support of *Polaris* fire-control and guidance systems. Award will be made on the basis of a continuation of services previously started by the above firm in support of General Electric-manufactured equipment. This notice is made for information purposes only. Other proposals cannot be considered for the above procurement. PR No. SP 1088-63. BuWeps Synopsis No. 103-63.

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U. S. Navy Ordnance Supply Office
Mechanicsburg, Pa.

Item 1. Fuze-rocket MK 191 Mod 1, to be manufactured in accordance with various BuOrd drawings and specs, FSN 1340-972-9709, 50,000 each. Item 2. Fuze-rocket MK 188 Mod O, to be manufactured in accordance with various BuOrd drawings and specs, FSN 1340-811-5985, 73,000 each. Both used in *Zuni* rocket. Delivery to various destinations. IFB 195-141-63-(K)-B. Bid opening 11-9-62.

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U. S. Army Engineer District, Jacksonville
575 Riverside Ave.
Jacksonville, Fla.

Construction of modifications to launch complex P-20, Cape Canaveral Missile Test Annex, Air Force Missile Test Center, Patrick Air Force Base, Fla. Job-IFB ENG-08-123-63-15B. Bid opening 11-15-62. Payment in advance of $10 per set of drawings and specs is required before papers will be furnished. Payment will not be refunded. Approximate cost—$700,000.

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Headquarters, U. S. Army Weapons Command
Rock Island, Ill.

Item 1. Mechanism electrical firing group assembly for launcher, rocket 3.5 in., to be in accordance with the drawings listed on engineering parts master list of drawings No. 7140325 and all applicable drawings and specifications as set forth in IFB. Stock No. 1055-714-0325-BO42—4375 each. Delivery to be F.O.B. Various destinations. IFB AMC(W)-11-199-63-195(B). Bid opening 11-20-62. Bid sets are obtainable from the nearest AMC district office or headquarters, U. S. Army Weapons Command, Rock Island, Ill.

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Purchasing Office
Range Procurement Div. (MTDRC-1)
Air Force Missile Test Center
Patrick AFB, Fla.

Procurement of materials and services for evaluation and testing of pulse amplitude and pulse code modulation system (PACM) telemetry system developed by Aeronutronic Div. of Ford Motor Co. This is the third of three phases of the experimental program. Subcontracting possibilities are limited due to the nature of the work. 1 each—PR 63-1062. Required delivery within 11 months from date of award of contract.

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Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Designing, furnishing, installing, testing and placing in initial operation an ARC air heater system. Consideration being given only to proposals that will guarantee maximum enthalpy levels of not less than 12,000 BTU/lb. at 500 psi chamber pressure with a mass flow of 0.2 lb/sec. of air. Guaranteed levels of performance up to 20,000 BTU/lb. are desired. It is contemplated that a firm, fixed-price contract will be issued for this procurement. Telephone requests should be directed to Hampton, Va. Phone: 722-7961, Ext. 4468. RFP L-2613. RFP due date 11-19-62.

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Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted for detail, design, fabrication and installation at N. R. D. S., Mercury, Nev., for two wall-mounted handling systems (manipulators) in accordance with spec 1425-P.S.-4, dated 9-18-62, plus related equipment, data and training. Only those firms who show evidence of their qualifications to perform this specialized work will be sent proposal packages. The procurement officer may order a facility and security survey of any requestor.


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**THERMODYNAMICS—HEAT TRANSFER** Investigations require the application of all modes of heat transfer in solids and in single and two phase fluids at pressures from space vacuum to hundreds of atmospheres, temperatures from cryogenic to those existing in highly performing flames. Products under study range from advanced gas turbines to liquid metal boilers.

**MISSILE & SPACE VEHICLES** Analyze mission and determine overall vehicle systems requirements; consider aerodynamic, thermodynamic, structural and guidance considerations as they affect selection of propulsion, propellant and guidance systems in order to establish basic structural and aerodynamic design.

**SYSTEMS ENGINEERING** Determine characteristics of energy conversion and power systems that are technically and economically feasible for development efforts. Duties include the analysis and evaluation of specific systems applications and participation in the pertinent analytic and experimental development program. (Connecticut only)

**EXPERIMENTAL TEST** Develop test procedures; direct parts fabrication, test rig assembly, instrumentation and facilities preparation; conduct test; analyze data; formulate test conclusions. Assignments are available in both air-breathing and non air-breathing programs ranging from current gas turbine engines to fuel cells.

**MECHANICAL DESIGN** Translate theoretical studies into workable hardware on a variety of complex, high precision energy conversion devices—both air-breathing and non air-breathing. Analytical ability necessary since the mechanical designer is expected to perform all but the most complex analyses.

**STRUCTURES** Analytical investigation, design and development of complex structures using conventional and unconventional materials and novel manufacturing processes. Object of this program is to develop improved lightweight, temperature-resistant structures for all types of energy conversion devices.

**FLUID MECHANICS** Analytical studies and design of fluid machinery for a variety of powerplants. Investigations range from the hydrodynamics of mixed flow, high head rise pumps to the separation of vapor and liquid phases in a reduced gravitational field.

**PERFORMANCE ANALYSIS** Analysis of gas turbine and fuel cell test data and test results with the objective of predicting trouble areas and recommending design changes necessary to improve performance characteristics. Strong aerodynamic, thermodynamic or combustion experience desirable.

**AIR-BREATHING PROPULSION CONCEPTS EVALUATION** Analytical evaluation of advanced propulsion systems concepts such as turbojets, turbofans and ram jets as they apply to subsonic, supersonic, hypersonic, V/STOL and marine vehicles. An advanced degree would be particularly desirable for these openings.

**STRESS ANALYSIS—VIBRATIONS** Analysis of structures subjected to both complex static loading and transient thermal loading, operating in an environment which is subject to vibratory loads. Requires strong applied mechanics background.

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# SINS-type Gyro Has Space Potential

**by Mike Getler**

GARDEN CITY, N.Y.—Space-flight applications now are being considered for a highly accurate guidance-system gyro developed here by Sperry Gyroscope Co.'s Marine Div. The device originally was developed primarily for shipboard inertial navigation systems (SINS).

Initially developed under a two-year, company-funded program and continued recently under Navy sponsorship, the Mk. 1 Mod. 3 gyro's first units will be delivered to the Navy early next year for evaluation as a SINS component. Sperry officials hope the gyro will become a "universal" SINS component applicable either for retrofit of existing systems or for design inclusion in a new, more advanced system.

Sperry holds SINS contracts for five Ethan Allen-class Fleet Ballistic Missile submarines; the Autonetics Div. of North American Aviation is presently supplying the SINS for the remainder of the FBM fleet.

Sperry has begun pilot production of the gyros, and company officials expect first decisions on aerospace system uses "in the near future." At least one major Air Force test center reportedly is evaluating the units.

The Mod. 3 gyro is an outgrowth of Sperry's Mod. 2 unit, which is employed with the Mk. 3 Mod. 0 SINS used in the five 608-class (Ethan-Allen) submarines. The Mod. 2 is a modified gas-bearing gyro, but the newer Mod. 3, the firm says, was designed from the start as a gas-bearing device.

The Mod. 3 is a floated single-degree-of-freedom integrating gyro utilizing a hydrodynamic gas bearing to support the rotor assembly.

• **Basic system**—The complete gyro consists of one large outer casing mounted directly to the shipboard inertial platform, plus a much smaller, hermetically-sealed container floated inside.

The sealed container houses the gyro rotor, stationary bearing, and gimbal assembly, as well as a fixed supply of support gas. As the gyro is excited electronically, causing rotor run-up, the relative motion between the rotor journal and the stationary bearing eventually pressurizes the gas within the case, separating the two elements and allowing the gyro wheel to spin freely on its gas cushion.

Considerable development effort recently on both hydrostatic and hydrodynamic gas bearings is due to their low drift rates, high reliability, low wear characteristics, reduced mechanical noise, improved temperature operating range, and ability to support high-g loadings.

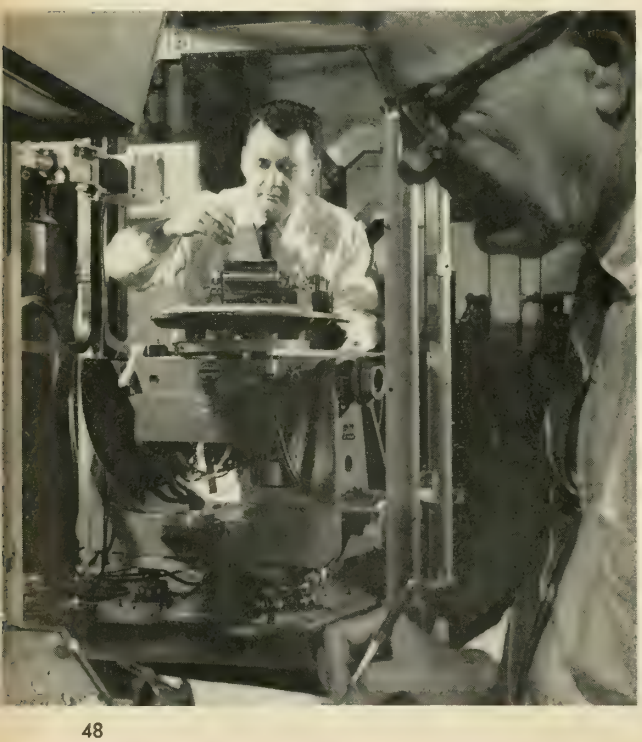
Advantages often cited by advocates of hydrodynamic bearings over hydrostatic techniques involve the absence of external gas supplies and pumps. The major design problem lies in the fact that some contact between gyro elements is necessary until rotor speed is sufficient to lift it clear of other support hardware.

In several thousand start-stop tests —considered to be the most likely operation in situations where hydrodynamic gas bearings encounter friction that could degrade performance—the Mod. 3 gyro reportedly emerged with no apparent wear or performance loss.

Sperry engineers also report that extensive use of beryllium throughout the Mod. 3 design has reduced weight, improved rigidity, and enhanced thermal characteristics.

• **Ligament suspension**—In addition to improvements inherent in the use of gas-bearing gyros, Sperry also claims greatly increased reliability is achieved by use of a unique ligament suspension system for radially and axially centering the gyro float within the outer casing.

The suspension technique is completely passive and is made up of eight thin flexible wires running from the float to the outer casing. The system, Sperry claims, is independent of the external electronics, turbine torques or friction common to such other types of suspension systems as magnetic, electrostatic, hydraulic or jewel-pivot suspension. Sperry claims it has built and shipped more than 600 gyros using ligament suspension techniques—without a single field failure reported.



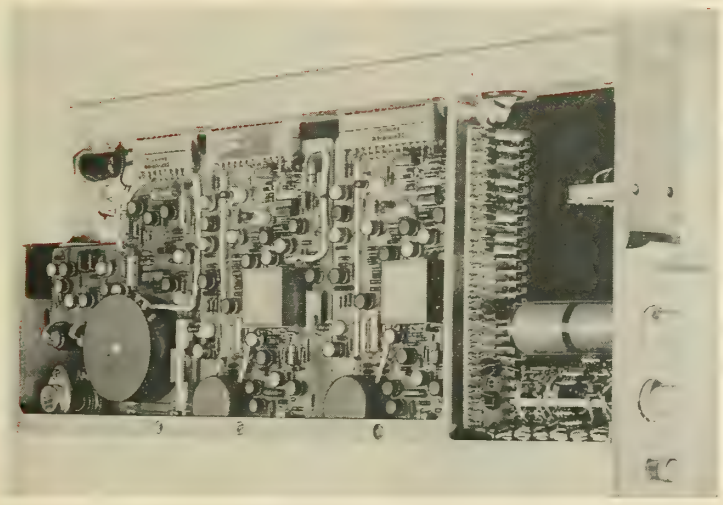
*"SOUP CAN"-size gyro, proposed by Sperry for host of sea-to-space applications, undergoes long-term drift stability test at company's test facility.*

In addition to their support role, the wires act as conductors to route power to the float, reportedly further enhancing reliability by removing other types of power and flex leads. Use of the passive suspension system in conjunction with an efficient spin motor assembly also is reported to have sharply reduced power requirements.

In its present configuration, the gyro uses a single electromagnetic pick-off to sense the rotational position of the gyro float about the output axis with respect to the outer casing. (The casing, in turn, is attached to the SINS platform.) Sperry engineers say the gyro is not limited to this type of pick-off. Capacitance and optical devices also may be used.

Actual Mod. 3 design and performance details are classified. But Sperry can report that the extensive development effort on this new gyro has made it 50% smaller, 75% lighter and 50% cheaper than the Mod. 2 now in service. Slew capacity reportedly has been at least tripled.

For all significant performance characteristics, engineers report that test data accumulated to date indicate an order-of-magnitude operational improvement with the Mod. 3 system. After several hundred hours of testing, drift rates were described as "infinitesimal." ⌘



## New Product of the Week: Low-Level DC Amplifier

Redcor Corp. is marketing a fast recovery low-level DC differential amplifier, Model 371. Incorporating a unique input circuit, the completely solid-state Model 371 provides the following features: fast recovery from differential and common mode overload of 80 microseconds, wideband common mode rejection, bandwidth unaffected by gain change, high cmr with wide bandwidth of 50 kc. The common-mode rejection ratio increases in direct proportion to increase in amplifier gain.

Settling time of 20 microseconds to 0.01%, gain accuracy and linearity of 0.01%, gaussian noise distribution and input impedance of 1000 megohms, are some of the specifications of Model 371.

Circle No. 225 on Subscriber Service Card

## Low-Cost Computer

A low-cost electronic computer designed specifically for small and medium-size business firms is available from International Business Machines Corp. Called the IBM 1440, the compact computer incorporates a major achievement in data storage technology —disc storage drives designed with interchangeable packs, each containing six magnetic memory discs for a combined storage capacity of nearly 3,000,000 characters of information.

The 14-in. memory discs are packaged in disc packs weighing less than 10 lbs. A disc pack can be removed from the 1440's disc storage drive by the operator in seconds, replaced by another pack containing different information, and then stored much like a book on a library shelf until needed again. This interchangeability feature gives the 1440 virtually unlimited data storage capacity.

A great advantage of the interchangeable memory feature is that a company can maintain separate disc packs for each of its major groups of records. When a job is to be processed, the disc pack containing the records for that job can be quickly placed on the disc drive for immediate processing. Providing random as well as sequential access to information, up to five file drives with nearly 15,000,000 characters of information can be attached to one system.

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## MAG-AMP Micro Diodes

Micro Semiconductor Corp. is offering ultra-low-leakage, high-conductance silicon micro diodes and dice for magnetic amplifier applications. Front-to-back resistance ratios in excess of $10^{10}$ are achieved with conductances greater than 400 mils at 1 volt. P.I.V. ranges of 1000 volts or more per single junction are a reality. Dissipation characteristics are 300 milliwatts for standard micro diodes; specials reach 750 milliwatts and more. Units will meet and exceed MIL-S-19600B specifications and are operational over 150°C.

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## Magnet System

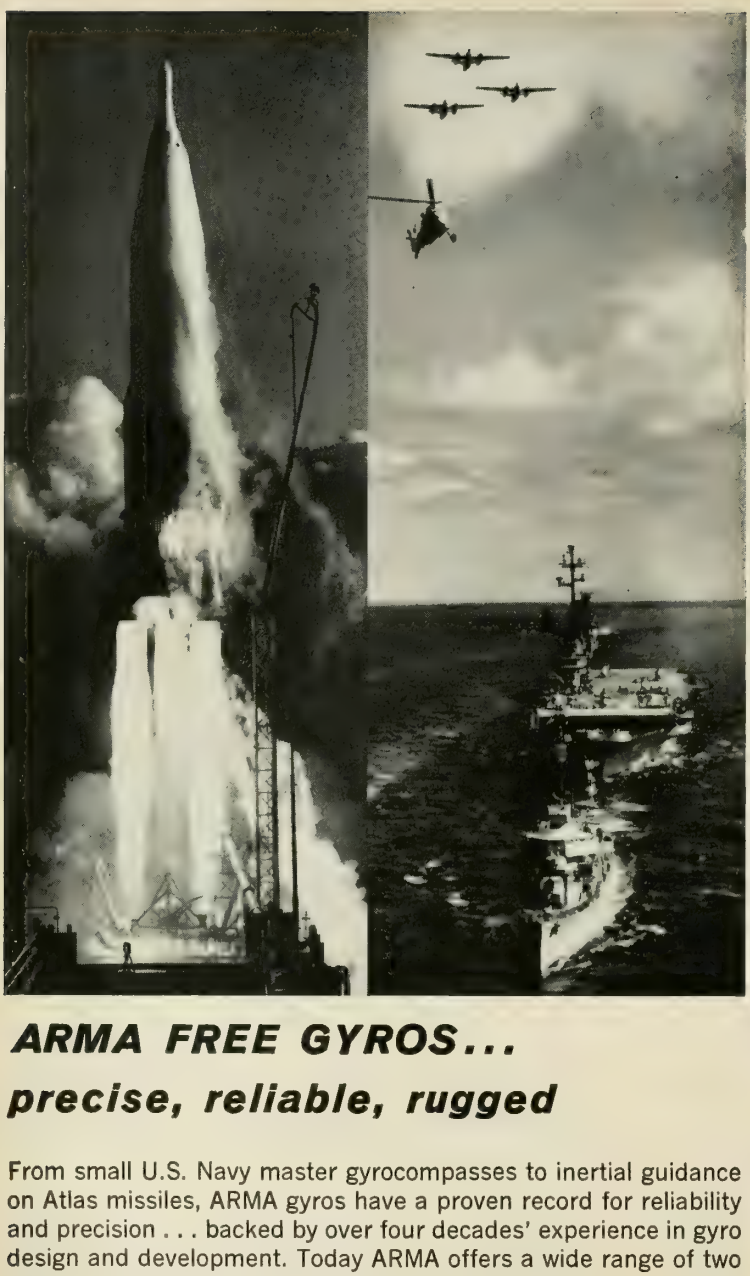
Varian Associates has developed a 6-in. magnet system that provides a high degree of field intensity and field homogeneity. The device, matched to the economical new 4 Kw solid-state V-2600 power supply, features continuous operation at full power input for fields up to 35 Kg. The compact, water-cooled power supply provides continuously adjustable current with unsurpassed regulation. Magnets are available with continuously adjustable or fixed air gaps, and with a choice of fixed, rotation and movable magnet mounts.

Circle No. 228 on Subscriber Service Card

## Delay Lines

Andersen Laboratories, Inc. is marketing a 250μsec., two-megacycle magnetostrictive delay line.

This line is capable of storing 500 bits of information in a return to zero mode of operation or 1000 bits in a non-return to zero mode. With a 10-volt drive pulse, this line has an output of 12 millivolts into 2000 ohms termina-



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tion, signal-to-noise ratios of better than 20 to 1 and temperature coefficients of 1/2PPm per degree Centigrade.

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## CW Traveling-Wave Tube

A 10-watt CW traveling-wave tube covering the 7.0-to-11-kmc range is available from the Power Tube Department of the General Electric Co. Minimum small signal gain is 30 db over the entire frequency band. The ZM-3107 is a lightweight, metal/ceramic tube designed for use in missiles, satellites and microwave relay systems. Both air and liquid-cooled versions are available.

Circle No. 230 on Subscriber Service Card

## Operational Amplifier

Ten megacycle bandwidth and dc voltage gain of one million are featured in the Model 1607 all silicon operational amplifier, developed by Burr-Brown, Inc. Output capability of ±10 volts at 20ma is provided with the unit operating on a dc supply of ±15 volts. Input drift is specified to be less than 25μv per degree of Centigrade. Input impedance is greater than 0.1 megohms and output impedance is less than 20 ohms.

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## Voltage Comparator

North Hills Electronics, Inc. offers a true rms voltage comparator, Model VC-1, which records in the dc to 10 kc frequency range with repeatability of about 0.01%. The instrument can be readily set up for precise measurement of absolute rms levels of unknown ac voltages, for accurate adjustment of unknown ac voltages to specific rms levels,



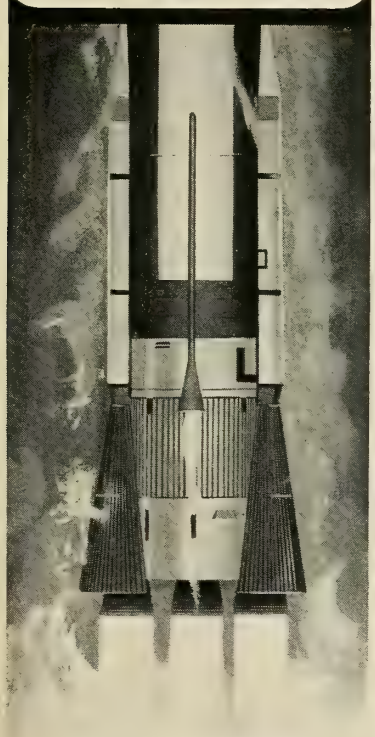
to monitor and record with high resolution the long-term stability of the rms output levels of highly regulated ac sources, as an ac to dc converter, transforming rms ac voltage levels into equal dc levels with high accuracy.

Circle No. 232 on Subscriber Service Card



Mod ART-750
5 x 8 x 4½ inches
less than 15 lbs.
750 ft. tape capacity

Mod TR-1875
4¼" dia. x 4¾" long
less than 3½ lbs.
14 channels



**ROUND TRIP RECORDING**

Shown are two examples of Concertone high environment miniature magnetic recorders tested and proven in the field. These highly compact and sophisticated data recorders have not only been designed for acquisition of information under severe environmental conditions, but equally important, have been engineered to *survive* and operate after the shock and vibration of a missile or satellite round trip. Light in weight and reliable, they have a wide variety of applications. Other miniature recorders available include endless-loop, satellite, sled- and missile-borne types.

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## *Space Electronics*

### Frequency Standard

Montronics offers the Model 101 frequency standard and comparator, which combines in a single portable package, a precision 1-mc crystal oscillator and a frequency comparator. The frequency-difference multiplier circuit of the comparator can provide from 10 to 10,000 times error multiplication (in decade steps) between two 1 mc signals, or 1 to 1000 times multiplication of error between two 100 kc signals. Rapid short-term comparisons can be made with a precision of one part in $10^{11}$.

Both the internal reference oscillator signal and the multiplied error signals are available from connectors on the instrument. Because of its high stability (± one part in $10^9$ over 24 hrs.), the internal reference oscillator can serve as a laboratory secondary standard.

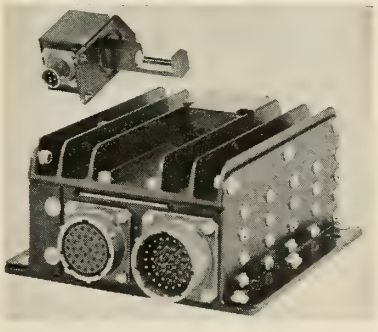
The device is fully transistorized and completely portable. Self-contained rechargeable batteries provide up to four hours of crystal oven and oscillator operation during transportation.

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### Detector System

In order to provide proper cooling for temperature-sensitive electronic devices used in military aircraft and missiles, Vap-Air has developed a completely solid-state cooling-effect detector system. The system consists of cooling effect detectors and a voltage regulator providing eight channels capable of unifying up to eight sensors, and a reliable means of varying temperature, humidity, density and weight flow.

The unit is offered in two types, the most common being the mercury-tube type while the nickel alloy unit is employed to accommodate low air flow at higher duct temperatures. Both detectors have an operating voltage of 28 VDC regulated with a power consumption of four watts in the case of the mercury tube and 100 watts (max.) in the case of the nickel alloy detector.



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An expert in unconventional applications and techniques is offered an exceptional opportunity to conduct fuzing studies for space interceptors in Hughes Advanced Projects Laboratory.

While fuzing experience would be helpful, it is not mandatory. Broad general background knowledge and high interest in the subject *is* required.

The assignment will entail parametric analysis of a wide variety of fuzing sensors (radar, infrared, nuclear, etc.) taking into account unusual geometries, accuracy requirements, and possible countermeasures.

*If you hold an accredited degree and U.S. Citizenship and feel that you are qualified by professional experience and interest, please airmail your complete resume to:*

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**TESTING** of turbines and other aerospace rotating hardware; thermodynamics and aerodynamics of turbine machinery, heat transfer, dynamics and stress analysis. Also R&D testing of control systems involving engineering mechanics, fluid mechanics and/or servomechanisms, and evaluation of product development programs on missiles, space vehicles and aircraft control equipment.

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## Space Electronics

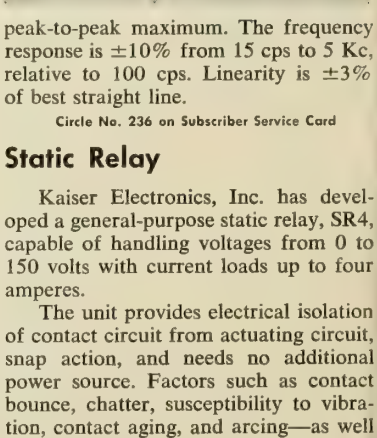
### Gated Clock

Navigation Computer Corp. is marketing the Model 501 Gated Clock. This module contains control logic elements for use in a 0.05% analog-to-digital converter. The elements include a multivibrator and sequence controller, a master reset generator, and a sign flip-flop. Other 500 series modules are available for building complete binary or binary-coded-decimal converters. These converters are compatible with Navcor 300 series and 400 series equipment and can be selected to meet the buyer's specific requirements.

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### Vibration Measuring System

A miniature airborne system for general-purpose measurement of vibration and low-g shocks is available from Gulton Industries. Operating in temperatures from −40°F to 185°F over the frequency range of 15 cps to 5 Kc, the Model KA-1079 system has a quiescent noise level of less than 50 millivolts



peak-to-peak maximum. The frequency response is ±10% from 15 cps to 5 Kc, relative to 100 cps. Linearity is ±3% of best straight line.

Circle No. 236 on Subscriber Service Card

### Static Relay

Kaiser Electronics, Inc. has developed a general-purpose static relay, SR4, capable of handling voltages from 0 to 150 volts with current loads up to four amperes.

The unit provides electrical isolation of contact circuit from actuating circuit, snap action, and needs no additional power source. Factors such as contact bounce, chatter, susceptibility to vibration, contact aging, and arcing—as well as other shortcomings inherent in electromechanical relays—are not present in this unit, and it offers high reliability, long life, and rapid switching. The relays remain stable between 55°C and 125°C, with a frequency response up to 500 cycles per second.

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*The Applied Physics Laboratory has several openings for engineers, physicists, and mathematicians in the senior and associate level for assignment to the APL-developed TRANSIT Satellite Navigation System. Principal duties of those employed will include contributing to the design of shipboard navigational equipment (receiver, demodulator, computer, printer), maintaining close liaison with manufacturing sub-contractors, supervising installation and debugging of equipment on Polaris submarines, and coordination of programming efforts involving state of the art real-time controls.*

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## Space Electronics

### Scope-O-Trol

A completely redesigned Scope-O-Trol has been announced by Acme Electric Corp. The unit is useful in connection with oscilloscope observations, in that it provides an opposing potential that cancels out the direct-current increment of a circuit being




checked so that both dc and ac steady-state and transient voltage changes can be observed on the scope in their true form.

The Scop-O-Trol operates from a 115-volt 60-cps circuit and provides an output from 0 to 50 volts dc. Input regulation ±0.005% for ±15% line change. Output voltage adjustable and stabilized ±0.015% at any selected voltage. Ripple is 0.002% peak to peak.

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### Terminal Block

A terminal block, Model C-1552, rated at 600 volts, 25 maximum working amps and which can withstand ambient temperatures from −65°F to 300°F is available from K and B Electric Products Co. The use of specially molded plastic as the material permits terminal block to flex and fit tightly on curved surfaces or bend in arc for cable hook-ups. The compact C-1552 will not break or chip, accepts up to #12 AWG solid wire and has a chamfered hole that quickly guides wire into place. A "positive protection" collar prevents accidental grounding even when screw is in maximum "up" position and ribs are integrally molded into collar for strong resistance to vibration.

Circle No. 239 on Subscriber Service Card

### Ground Checkout Unit

The AN/MSM-70, an automatic checkout unit developed for the *Bomarc* interceptor system, will be marketed by the Boeing Co. The equipment completes its tests in 58 min. The early *Bomarc* checkout system required 45 days and numerous test engineers. The





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He must have a personality which enables him to work easily and well with a variety of people—plus intellectual speed which permits him to react quickly to any situation. He must be inventive and imaginative, will probably hold several patents and will have had papers published in professional journals. His present position might be that of a preliminary design section head or staff head in an equipment design group.

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unit consists of two major elements—a programer-evaluator and a set of stimulus generators. It tests elements such as electronic flight controls, radar beacons, hydraulics, temperatures, pressures and engine conditions.

The programer-evaluator controls the test sequence, power inputs and stimulus generation, as well as monitoring and evaluating test results. Punched cards direct test sequences, results of which activate colored lights and are printed on paper tape. Stimulus generators feed electrical impulses to the subsystems under test. Makeup of the generators varies with the missile or aircraft being tested.

Circle No. 240 on Subscriber Service Card

## Transistor Sockets

Tamar Electronics Industries, Inc. is marketing a line of microminiature transistor socket assemblies designed for dip soldering with no heat damage to components.

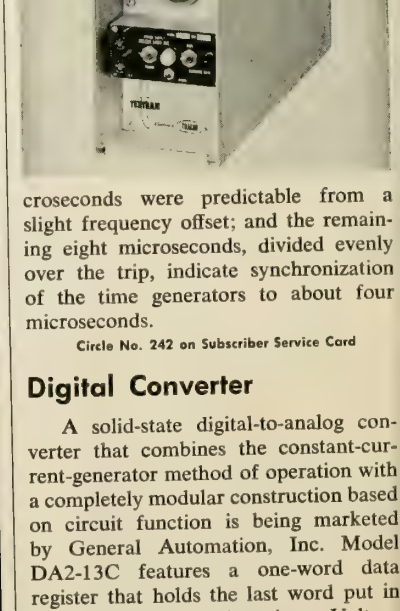
The socket contacts are available as separate components or as part of a socket assembly. They have pin diameters of 0.17, 0.030, 0.040, 0.050 and 0.060±0.001 in. They have a contact separation force of 8 oz. maximum, 1 oz. minimum. Pin and socket contacts for transistors are available from 0.016 to 0.062 dia. They have a contact resistance of 0.5 milliohms and temperature range from −100°F to 400°F.

The socket assemblies and heat sinks are for three or four pin transistors with 0.017 diameter leads and 0.200 dia. spacing.

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## Portable Oscillator

Textran Division of Tracor, Inc. is marketing a portable crystal oscillator clock designed specifically for such applications as use to synchronize the range time generators. The unit was carried by car a distance of some 241 miles and was found to have gained only 18 microseconds (.000018) over the nine-hour period. Of these, 10 microseconds were predictable from a slight frequency offset; and the remaining eight microseconds, divided evenly over the trip, indicate synchronization of the time generators to about four microseconds.



Circle No. 242 on Subscriber Service Card

## Digital Converter

A solid-state digital-to-analog converter that combines the constant-current-generator method of operation with a completely modular construction based on circuit function is being marketed by General Automation, Inc. Model DA2-13C features a one-word data register that holds the last word put in until the new word arrives. Voltage output for each word remains constant until the next word calling for a different output comes along. Accuracy of the unit is ±0.01% and word lengths range from 2 to 13 bits (sign bit optional). Set and reset inputs for each bit and a


## SCIENTISTS and ENGINEERS

*Increased activity in all current Ion Physics Corporation programs, both government and company sponsored, requires an expansion of our scientific staff. Those capable of contributing to advances in ion physics, space system design and integration, advanced power conversion system design, environmental simulation problems, and related solid-state techniques are cordially invited to consider joining ION PHYSICS CORPORATION (a subsidiary of High Voltage Engineering Corporation), Burlington, Mass.*

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### SOLID STATE ELECTRONICS

Scientists required to study formation of solid state devices and integrated microcircuitry using ion implantation and plasma technques. Major areas are development of solar cells and monocrystalline thin film active elements. Initial investigations on solid state radiation detectors are currently being conducted.

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sample pulse input are supplied. The converter is available as a bipolar unit (±10 volts at 20 ma) or polar unit (−grid to ±10 volts).

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## Frequency Converter

A frequency-to-voltage converter with the reliability, stability and linearity required for flow, frequency, rpm and other measurement and control applications has been developed by Vidar Corp. Designed for multiple-range operation, the all-solid-state Vidar 322 precisely converts frequency to dc voltage providing a 0 to 10-volt signal capable of directly driving galvanometers, magnetic recorders, computers, oscilloscope monitors, digitizers, servo valve actuators, speed control devices, and other data handling equipment.

Technical features include: three full-scale ranges with choice of frequency insert cards from 500 cps to 100 kc; integral regulated power supply; floating input; 0.1% stability and linearity; metered output voltage; output impedance less than 0.25 ohms; auxiliary pulse output and variable 10-turn span control providing 3-to-1 adjustment of full-scale frequency.

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## Digital Voltmeter

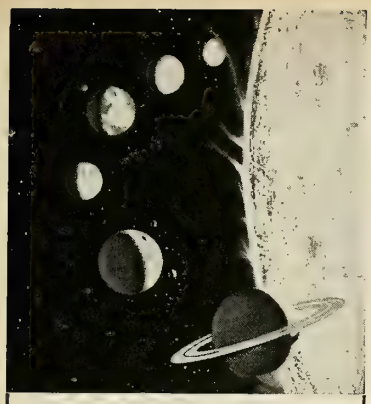
Digital Measurements Ltd. is marketing the DM2020 digital voltmeter similar in concept to the DM2001 but with considerably enhanced performance. As with the DM2001, the reading is displayed in decimal form on five in-line numerical indicators and is also available as a one-in-ten decimal coded output. The scale length is increased to 19999 with maximum resolution of



one digit in the last window.

Of the six input voltage ranges provided, five cover the normal range of 10 microvolts to 1999.9 volts, and the sixth offers an externally selected (i.e. elastic) scale facility. For checking purposes, the instrument may set directly against an included Weston Standard Cell on the 1.9999V range. Specified accuracy on this range is 0.01% of reading one digit.

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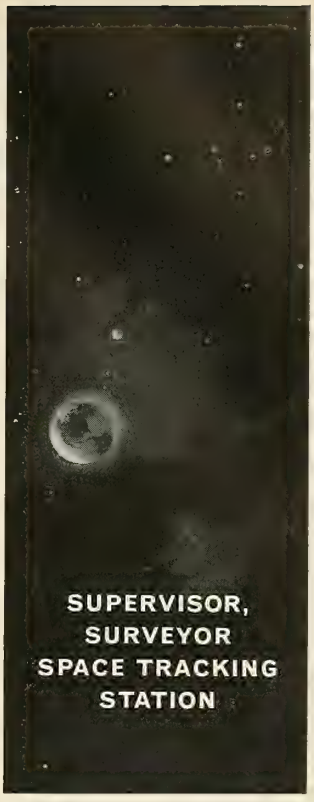
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# names in the news

**Lee Porst:** Appointed vice president of Sonex, Inc., Philadelphia.

**John T. Ralph:** Appointed executive assistant to the president of United-Carr Fastener Corp., Boston.

**B. F. Dittman:** Named chief engineer at Vickers, Inc.'s Torrance, Calif., plant.

**George A. Chappell, Jr.:** Appointed general manager of American Machine & Foundry Co.'s Buffalo, N.Y., division.

**William J. Henderson:** Appointed executive vice president of Victory Electronics, Inc., Syosset, N.Y.

**Robert Moore:** Elected vice president and eastern representative of Colby Crane and Manufacturing Co., New York.

**Dr. Bernard Levine:** Named manager of applications research at Martin Co.'s Space Systems Div., Baltimore.

**Dr. Charles R. Burrows:** Appointed senior scientist of Radio Engineering Laboratories, Inc., Long Island City, N.Y.

**Lt. Col. Melvin D. Clark:** Named chief of the Atlantic Missile Range Army Field Office at Patrick AFB, Fla.

**Col. Roland Paul West (USA ret.):** Appointed president of Paul Hardeman International, S. A., Stanton, Calif.

**Ray E. Williams:** Appointed production manager, air data systems, at the Guidance and Control Systems Div. of Litton Industries, Inc., Woodland Hills, Calif.

**Leonard F. Verdery:** Named vice president of engineering at Ortronix, Inc., Orlando, Fla.

**Thomas W. Coughlin:** Named manager of the Cambridge, Md. Div. of Airpax Electronics, Inc.

**Stanley H. Ireland:** Appointed director of advertising for Robertshaw-Fulton's Aeronautical and Instrument Div., Anaheim, Calif.

**Col. Norair M. Lulejian (USAF ret.):** Joined the advanced planning staff of United Aircraft Corp., East Hartford.

**W. W. McFarland:** Elected chairman of the board of directors of Hazeltine Corp., Little Neck, N.Y. **R. L. Beam** elected president and chief executive officer.

**Stephen Einig:** Appointed director of marketing for the Defense Products Div. of Fairchild Camera and Instrument Corp., Syosset, N.Y.

**Kenneth W. Peterson:** Named manager of quality control at Pickard & Burns, Inc., Waltham, Mass. **Perry C. Smith** appointed manager of marketing.

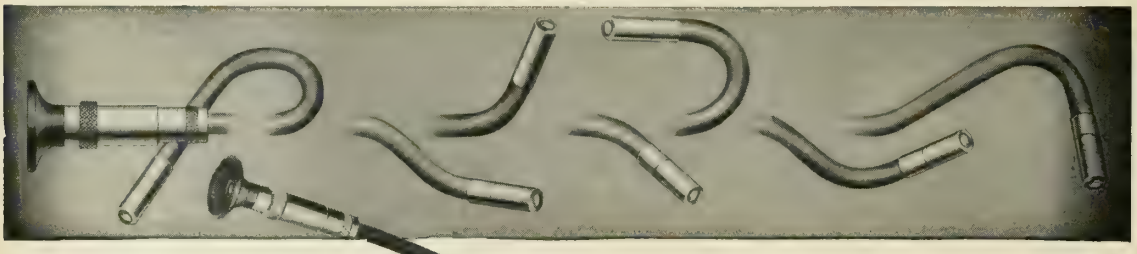
**John T. McGraw:** Appointed executive vice president of the Vard Div. of Royal Industries, Inc., Pasadena, Calif.

**James R. Riedmeyer:** Appointed assistant general manager of the TAMAR Electronics Microwave Div. of Electronics Industries, Inc., Anaheim, Calif.

**James E. Holland:** Appointed manager of the Guidance Sensors Dept. in the STL Guidance Laboratory, Redondo Beach, Calif.

**Dr. Jerome P. Keuper:** Resigned as manager of systems for Radio Corp. of America at Atlantic Missile Range to accept presidency of Brevard Engineering College, Melbourne, Fla.

**Scott A. Rogers, Jr.:** Named president of Parker-Hannifin Industrial Group, Parker-Hannifin Corp., Cleveland.

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### NOVEMBER

**Northeast Electronics Research and Engineering Meeting, IRE,** Commonwealth Armory & Somerset Hotel, Boston, Nov. 5-7.

**Symposium on Lasers and Applications,** Antenna Laboratory, Dept. of Electrical Engineering, Ohio State University, Columbus, Ohio, Nov. 7-8.

**Eighth Annual Conference on Magnetism and Magnetic Materials, IRE,** Penn-Sheraton Hotel, Pittsburgh, Nov. 12-15.

**Retardation and Recovery Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory,** Imperial Motel, Dayton, Ohio, Nov. 13-14.

**National Symposium on Materials Compatibility and Contamination Control Processes, Society of Aerospace Materials and Process Engineers,** Hollywood Roosevelt Hotel, Hollywood, Calif., Nov. 13-15.

**Seventeenth Annual Meeting and Space Exposition, sponsored by ARS,** Pan Pacific Auditorium, Los Angeles, Nov. 13-18.

**Mid-America Electronics Conference, IRE,** Hotel Continental, Kansas City, Mo., Nov. 19-20.

**ASME Winter Annual Meeting,** Statler Hilton Hotel, New York City, Nov. 25-30.

**Western States Section Meeting, The Combustion Institute,** Aerojet-General Corp., Sacramento, Calif., Nov. 26-27.

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# The Ethics of Fame

FAME AND HONOR, in this nation at this time, all too frequently are considered inseparable. They are not. It is possible to have fame without honor and honor without fame.

We are reminded of this by a news item concerning Army Maj. Lawrence R. Bailey, who has received the Bronze Star and Purple Heart following his release by the Pathet Lao after months of brutal treatment.

You may recall the news photographs of Maj. Bailey being carried on a stretcher from the aircraft that brought him home.

The citizens of the major's hometown of Laurel, Md., recently tried to present him with an automobile as a token of their appreciation. Declining, Maj. Bailey suggested the money be used to establish a scholarship fund.

We could not help but contrast the major's action with those of our seven astronauts.

We are well aware that the astronauts are brave, courageous and dedicated men who wear their fame with proper public humility. But they have shown a singular lack of character when it comes to the question of profiteering on their fame.

We are weary of speculation in motels, apartment buildings and other real estate. We find little to admire when the directors of a large aerospace firm almost come to blows over the possibility of investment by the astronauts. We find nothing noble in the renting by NASA of luxury apartments with wrought-iron stairways and a 50-ft. swimming pool under the guise of Houston "working quarters" for the astronauts. We find nothing to applaud in the rejection of the offer of free homes in Houston—after acceptance of the real-estate promoter's scheme became public.

We find nothing but revulsion in the deal which set the whole thing in motion, the half-million-dollar sale of exclusive rights to their personal stories to *LIFE* magazine. They have sold their stories and the stories of their wives to the highest bidder in a crass commercialization of man's first step to the stars.

The astronauts can aver they were badly advised by their business manager—and they were. They can say they were poorly led on this matter by their superiors at NASA—and they were. But these men of space are supposed to be the finest of our land, men of Homeric stature who are leaders and advisers in matters of honor in the best classical tradition.

They should need no business manager, they should require no advice on this. Where is the strength of character to lead the nation, not to follow the unethical advice of others?

The seven gentlemen are the first into space, but they have left the path littered with unpleasant debris. Let them take a day away from the centrifuge and study what the philosophers have to say about the ethics of fame.

Aristotle has described for them in the Nicomachean Ethics the behavior of the honorable man of courage: "He will face great dangers, and when he is in danger he is unsparing of his life, knowing that there are conditions on which life is not worth having. And he is the sort of man to confer benefits, but he is ashamed of receiving them; for the one is the mark of a superior, the other of an inferior."

Seneca tells us: "The reward of a thing well done is to have done it." Or again, Montaigne: "The actions of virtue are too noble in themselves to see any other reward than from their own value."

Our first astronauts have displayed the highest courage and reaped the fame justly due them. But to deal in apartments and motels with profits from their achievements is to demean those achievements and to demean themselves.

Their deeds of courage are not the only deeds of courage in our nation. Military pilots risk their lives daily even in peacetime, without a single motel to show for it. The astronauts have given their country no fuller measure than Maj. Dick Bong, who died in the flaming crash of a P-80 after becoming the top Pacific ace, or Maj. Tom Lynch, who was killed when his P-38 exploded off Tadji in the South Pacific. They have given no more than a naval reserve lieutenant killed on a weekend training flight.

The astronauts know this. They are not seeking the fame heaped upon them. It is apparent that, as men of humility, they are frequently made uncomfortable by it. In this, they should rest easy. There is nothing intrinsically wrong with selling an article to *LIFE* magazine. Many a pilot has done it. Maj. Bailey's story would make worthy reading in a national publication.

It is the manner and volume of the commercial dealings of the astronauts that are improper, in the most classical sense, for honorable men.

THEY ALONE are not at fault. It is to the discredit of our industry and our society that we let these men be tempted by the cheap profit motives of a mass magazine, that we did not advise or lead them better. But if these are men of true greatness, they must be the leaders and set proper standards for others. To date, they have failed, not in bravery and accomplishment but in honor and reputation.

It is not too late for them to remedy this, to set classic standards for those who will follow. Much depends on their leadership, not upon rules promulgated by NASA or the Air Force.

As it is, our heroes have feet of clay and it leaves us uncomfortable.

For contemplation in orbit, we can offer the astronauts no better advice than another quotation from the Essays of Montaigne: "The virtue of the soul does not consist in flying high, but in walking orderly."

**William J. Coughlin**

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# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



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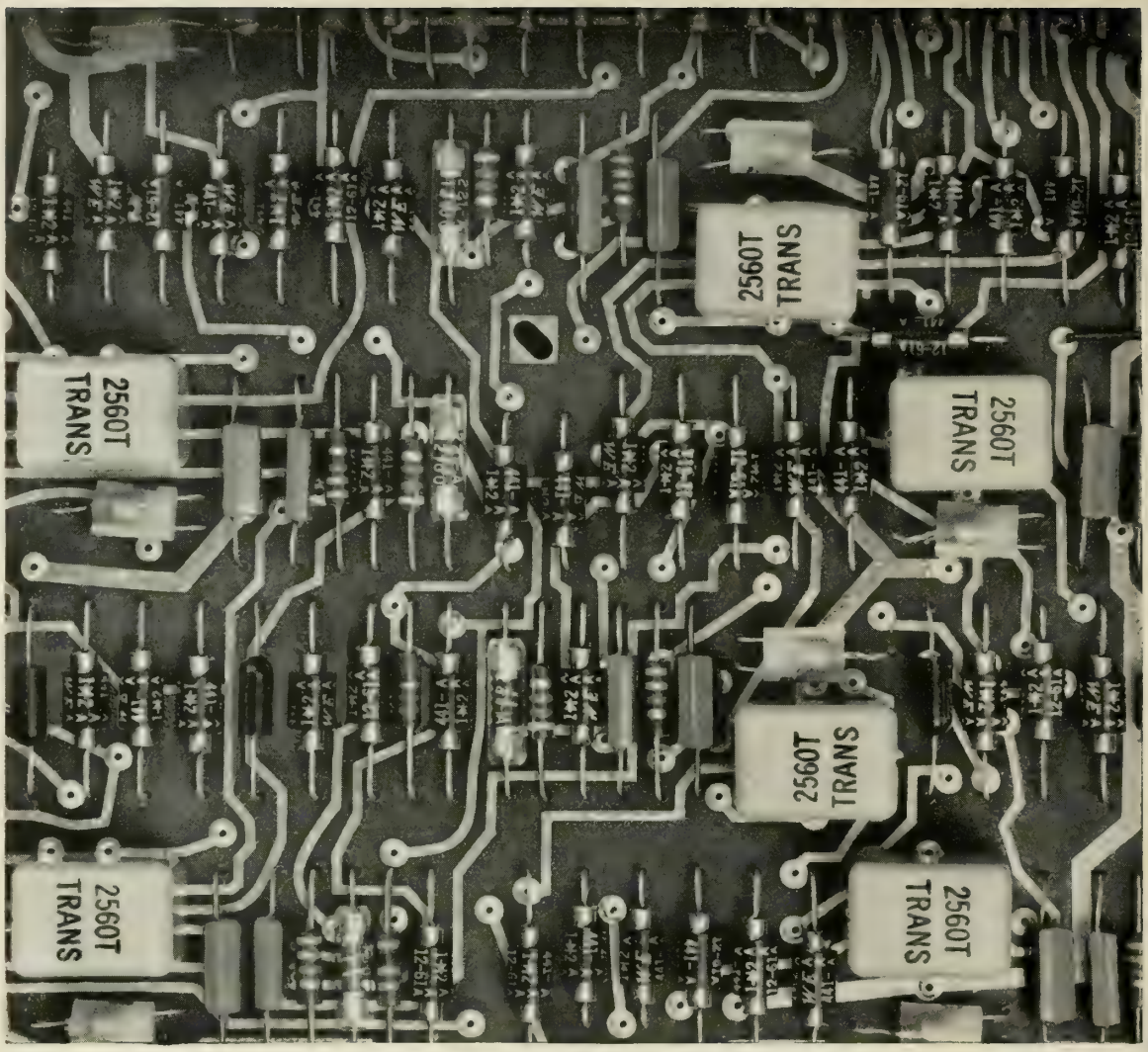
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# missiles and rockets

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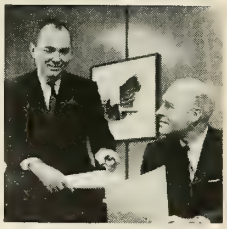
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## THE COVER

*General Manager John B. Lawson (seated) and Dr. Donal B. Duncan, assistant general manager, of the Aeronutronic Div. of Ford Motor Co. map plans for the division's production expansion. See p. 37.*



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# letters

## Cuban Crisis

*To the Editor:*

Your Oct. 29 editorial ("Responsibility in Crisis") was worth the cost of the whole year's subscription to your magazine.

It is a gift to be able to write such a comprehensive editorial, and it is even a greater gift to have such a wonderful understanding and appraisal of the subject on which you are writing.

K. T. Keller
Detroit

*To the Editor:*

Your Oct. 29 editorial was well-written and to the point. It has been well received by all who have read it, and we feel that it has a special message to every man associated with the country's defense program.

The fact that few people, other than subscribers to your magazine, will have an opportunity to read this thought-provoking editorial has prompted me to make the following request: If at all possible, please send us twelve extra copies of the editorial. We wish to circulate these throughout our test facility—to management, engineers, and craftsmen.

A. D. Jarratt
Assistant Manager
TOB, T-Div., RTF
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## Pearl River County

*To the Editor:*

Your Oct. 1 article concerning the NASA Test Facility to be built in Mississippi at a construction cost of one-half billion was of interest to me. I have a childish faith in the law of the land, and know that award of contracts to contractors practicing discrimination is unlawful. I suspect that the contractors working in Pearl River County, Mississippi, will not worry too much about discrimination, in that there won't be much protest in the locality. In fact, things are so controlled in Pearl River County that, according to the Voting Volume of the 1961 Report of the U.S. Commission on Civil Rights, no Negro is registered to vote in this county. According to the U.S. Supreme Court, that is *prima facie* evidence of discrimination!

Despite the fact that Massachusetts is the home of Dr. Goddard (the liquid-propelled rocket), Dr. Kantrowitz of Avco Everett (re-entry), Dr. Aiken of Harvard and others at MIT (the electronic digital computer), and Dr. Draper of MIT (inertial guidance), Massachusetts manages to get fewer space contracts. In fact, NASA spends thousands of times more money per scientist, per mathematician, or per engineer in Mississippi and Texas than in Massachusetts.

We could use some work in the peaceful exploration of space. Mr. Kennedy promised, in his campaign for Senator, that he "can do more for Massachusetts." I fail to see how he can do more as Junior Senator than his brother has done as President.

Apparently the best way to assure one's state's position in the space race is to shoot foreign correspondents in the back, and segregate. It helps to have a Representative or Senator on the appropriations committees, I suppose, with plenty of seniority from a one-party system.

Nathaniel A. Denman
Cape Cod, Mass.

## Chinese Puzzle

*To the Editor:*

Willy Ley, in his widely read "Rockets, Missiles and Space Travel," states that Wan Hu, a Chinese mandarin, in about 1500 attempted to propel a sled by the force of some 47 rockets; this experiment, of course, was unsuccessful.

Yet just recently I have come across a 1957 public relations pamphlet from the Reaction Motors Div. of Thiokol Chemical Corp., Denville, N.J., entitled "This Is RMI Power for Progress," which states that in 1237 Chou Foo Ling "made an attempt to propel a sled by rocket power."

Which version is correct and just where and when did this legend originate? Perhaps one of your readers might know.

I look forward to each new issue of your magazine. Keep up the good work.

F. H. W.
Venice, Calif.

*The familiar story of Wan Hu appears in various sources. He purportedly tried to launch himself on an arrangement of two kites—and was killed in the process. The Chou Foo Ling tale is new to us. It is generally accepted that the Chinese first used rockets in warfare as early as 1232 A.D., but we have found no references to any Thirteenth Century efforts in rocket travel. Has anyone else?—Ed.*

## Safe Assumption

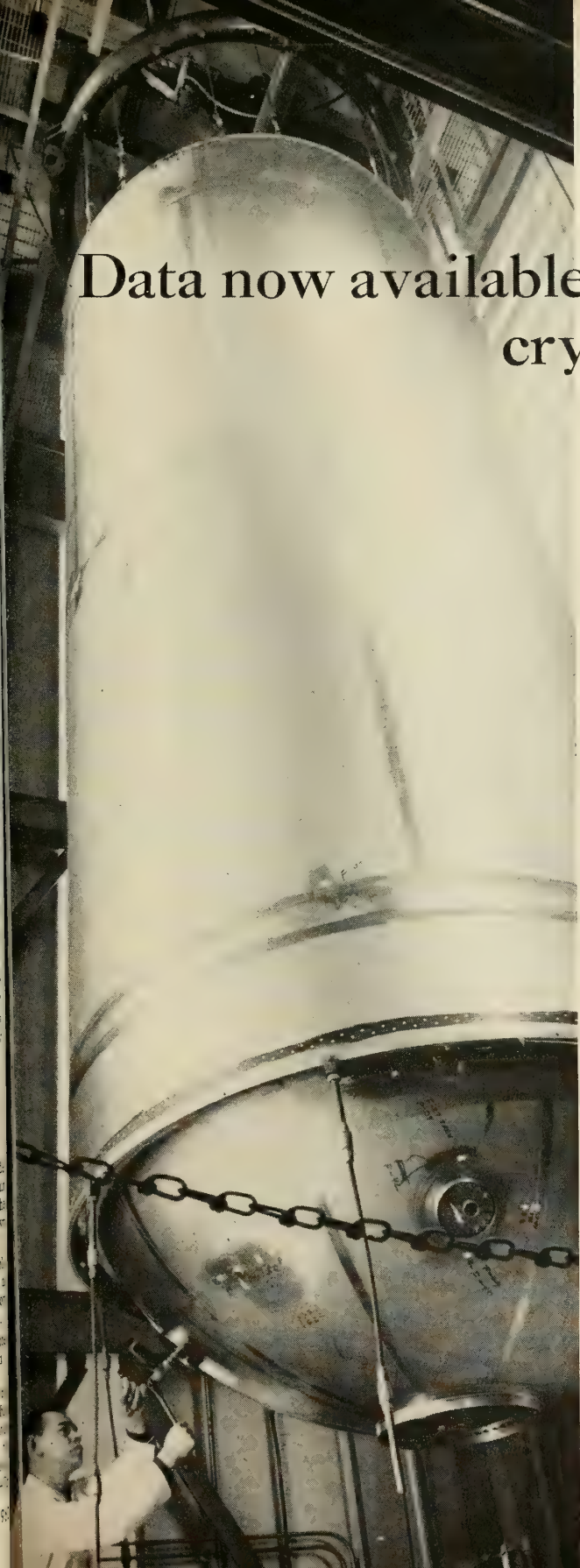
*To the Editor:*

In your article "Congress May Ride Close Herd" (M/R, Oct. 22, p. 16), your reporter blithely assumes leadership of the House Space Committee passing down from one Democrat to another.

As the election approaches, a Republican majority does not seem too remote as to exclude Representatives Martin, Fulton, etc., from the chairmanship speculation.

R. A. Carpenter
Bethesda, Md.

*M/R certainly took no sides in the Congressional elections; however, the best available consensus long before election day was that it was virtually impossible for the Republicans to gain the 44 seats they needed to gain control of the House.—Ed.*



*7,000 gal. titanium tank for liquid hydrogen built by Beech Aircraft*

# Data now available on Titanium's cryogenic properties

Titanium can hold more liquid hydrogen at less tank weight than any other material and still give you impermeability to hydrogen, generous elongations and notch toughness at –423F.

**Some specifics.** The liquid hydrogen tank shown here was built and successfully hydrostatically tested by Beech Aircraft Corp. Capacity: 7,000 gallons. It was fabricated from sheet supplied by Titanium Metals Corporation of America to less than AISI tolerances, in thicknesses ranging from 0.014 to 0.025 inches.

**Cryogenic alloys.** The alloy used was Ti-6A1-4V ELI, one of two alloy grades advanced by TMCA specifically for liquid hydrogen service. The other grade is Ti-5A1-2.5Sn ELI. The designation ELI stands for Extra-Low Interstitials. Typical properties of these grades at –423F:

**Ti-6Al-4V ELI:** tensile strength, 263 ksi; yield strength, 248 ksi; notch tensile strength, 211 ksi; elongation, 7%.

**Ti-5Al-2.5Sn ELI:** tensile strength, 229 ksi; yield strength, 206 ksi; notched tensile strength, 233 ksi; elongation, 15%. Compare these properties with stainless and aluminum. You'll see why titanium guarantees more payload!

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A new solid state radar system built by STL engineers and scientists can send out and receive signals at X-band frequencies to help man rendezvous and dock vehicles in space. STELATRAC is its name. It is the first solid state system of its kind. The X-band transmitter is shown above. It has successfully passed temperature and vibration tests. STELATRAC can also be used as a command link between vehicles in flight. By altering its module design, the flexible radar system operates as an altimeter and doppler velocity sensor to guide spacecraft safely to the surface of the moon and planets. Today STL is busy on many such projects as STELATRAC. STL is also prime contractor for NASA's OGO and a new series of classified spacecraft for Air Force-ARPA. And STL continues Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in Theoretical Physics • Systems Engineering • Radar Systems • Experimental Physics • Applied Mathematics • Space Communications • Antennas and Microwaves • Inertial Guidance • Analog Computers • Solid State Physics • Computer Design • Telecommunications • Space Physics • Digital Computers • Guidance & Navigation • Electromechanical Devices • Engineering Mechanics • Aerodynamics • Propulsion Systems. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, Department B12, One Space Park, Redondo Beach, California, or Box 4277, Patrick AFB, Florida. Your inquiry will receive a prompt reply. STL is an equal opportunity employer.

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# The Countdown

## WASHINGTON

### Soviet Mars Failure Reported

It hasn't been confirmed but Pentagon insiders report that the successful Soviet Mars shot was the second of two attempts within a week. The first failed. Estimates place the thrust of the improved Russian booster at 1.2 million lbs. This indicates a further widening of the gap with the U.S. Earlier Soviet space shots relied on an 800,000 lb. thrust vehicle.

### Delivery of First Gemini Capsule Set

McDonnell Aircraft is scheduled to deliver the first *Gemini* spacecraft to NASA in mid-February. The company isn't very happy, incidentally, with descriptions of *Gemini* as an intermediate step between *Mercury* and *Apollo*. Program officials believe *Gemini* has a strong potential of its own, both civilian and military.

### U-2 Hit by High-Altitude Missile

Military sources say the advanced Soviet antiaircraft rocket which shot down Maj. Rudolph Anderson's U-2 over Cuba was similar to the Army's *Nike-Hercules*. The *Hercules* has a ceiling of 150,000 ft., which would place the U-2 operating altitude well within range of the Russian rocket.

### LLV Studies Due Next Month

Feasibility studies on the lunar logistic vehicle will go to NASA in about three weeks. Companies participating are Grumman, Northrop and Space Technology Laboratories. Winning of the lunar excursion module award virtually knocks Grumman out of this competition. Contract will be awarded early next year.

### Army Ending Zeus Testing at Pt. Mugu

The Army will wind up its *Nike-Zeus* test activities at Pt. Mugu, Calif., by Jan. 1. Fifteen *Zeus* launches have been made from there. The series may end with one or two more shots before activities shift exclusively to White Sands and Kwajalein.

### Battle for Funds Within NASA

A battle for Fiscal 1964 budget funds is shaping up within NASA between the manned spaceflight and unmanned scientific exploration programs. Biggest losers in early skirmishing for Fiscal '63 funds have been the scientific and communication satellite programs.

### U.S. Scientific Leadership Questioned

Some top U.S. scientists say claims of a lead over Russia in scientific space exploration are ridiculous. They point out that the Soviets have launched 11 scientific satellites in the past year, all of them heavy craft requiring boosters approaching *Saturn* class. These experts charge that the U.S. won't be able to duplicate the Russian achievement until its scientific observatories are launched—two to four years from now.

### Is There Any Life on Earth?

Only one of the many thousands of photographs taken by the *Tiros* weather satellites has shown any signs that Earth is inhabited. White criss-crossed lines on a photograph of the Northern hemisphere turned out to be snow-clogged logging roads cut in a Canadian lumber forest.

### NASA Studies Possible ANNA Take-over

NASA is establishing a three-man committee to study possible take-over of the *ANNA* geodetic satellite program. The Navy currently runs the joint military-civilian project. Biggest roadblock to a transfer to NASA is funding approval.

## INDUSTRY

### Drum Tests for TOW Are Successful

Tests of non-rotating, wire-dispensing drums for the Army's *TOW* wire-guided missile were carried out successfully at the Air Force's Missile Development Center at Holloman AFB. Some 45 sled runs tested unwinding of the wire in flight, its ability to sustain electrical signals and aerodynamic behavior of the missile. Drums were designed by Hughes Aircraft and Martin Co.

### Find Assembly of Syncom Completed

Hughes Aircraft has completed final assembly of its *Syncom* satellite. It now is in final checkout before delivery to NASA at Cape Canaveral. Launch aboard a *Delta* booster is set for early next year.

### Moon Dust May Be Pretty Hard

Armour Research Foundation scientists say initial experiments for NASA indicate dust particles become harder and more firmly knit under conditions of high vacuum such as exist on the Moon. Further studies are being made to determine whether the expected lunar dust may not consist of particles bonded together in a rock-like substance.

### DSIF Antenna to be Operational in '65

First of three 210-ft.-dia. parabolic antennas for the Deep Space Instrumentation Facility is to be operational in 1965 at JPL's Goldstone, Calif., station. The other two will be in operation by 1967 at Johannesburg, South Africa, and Woomera, Australia. Space communications capacity of the DSIF will be improved by a factor of 10 when the big dishes replace the present 85-ft.-dia. receivers.

## INTERNATIONAL

### First European Hawk Is Tested

First test firing of the European-built *Hawk* at Colomb-Béchar in late October destroyed a *CT-20* target missile. Belgian, Dutch, French, German and Italian companies are cooperating on the Raytheon-designed NATO missile.

### Australia Developing ASW Missile System

Development of an antisubmarine guided missile system has been undertaken by the Australian Ministry of Defense with substantial financial assistance from the U.S. Early reports are of a promising design.

### Vostok Expert Is Killed

Col. Peter Dolgov, a leading Soviet expert on the design and use of ejection seats, is reported to have been killed in the line of duty. He was one of those responsible for developing the landing system of the Vostok spacecraft.

# The Missile/Space Week

## Soviets Launch Mars Probe

*Mars-I*—a 1965 lb. automatic interplanetary station launched from a heavier satellite in a parking orbit Nov. 2—will pass over the surface of Mars at altitudes ranging from 621 to 6831 miles, according to the Soviet News Agency Tass.

Although the space probe was reported to be on a trajectory that would take it within 162,000 miles of the planet, Soviet scientists said that *Mars-I* was well within the initial trajectory error of 300,000 miles. A "precise system of star orientation and special engines" will be fired to correct the trajectory to bring it closer to the planet, Tass said.

The interplanetary spacecraft—expected to pass Mars about June 25, 1963 when the planet is 150 million miles from Earth—has three primary objectives:

—Prolonged exploration of outer space during the flight to include analysis of interplanetary plasma, meteoric impacts and gravity measurements.

—Establish interplanetary space radio communications to transmit the physical conditions of the vehicle, such as temperature, pressure and humidity, and trajectory data.

—Photograph the surface of Mars and relay the pictures back to Earth.

Six photographs of the spacecraft in flight were made by Crimean Astrophysical Observatory's 100-in. reflecting telescope using an "electronic optical light receiver." These devices were said to cut the exposure time by a factor of 100. It is believed to be the first time that an interplanetary vehicle has been photographed in flight.

Although the Soviets plan to transmit the photos of Mars to Earth by radio, a comment by Soviet Academician M. Sissakian indicates that they may also be planning to return the spacecraft to the vicinity of Earth. This procedure was used with the Soviet's *Lunik* vehicle, which obtained photos of the back side of the moon.

The earliest U.S. *Mars* shot is planned for the next "launch window" in 1964.

## Boeing Union Shop Vote Set

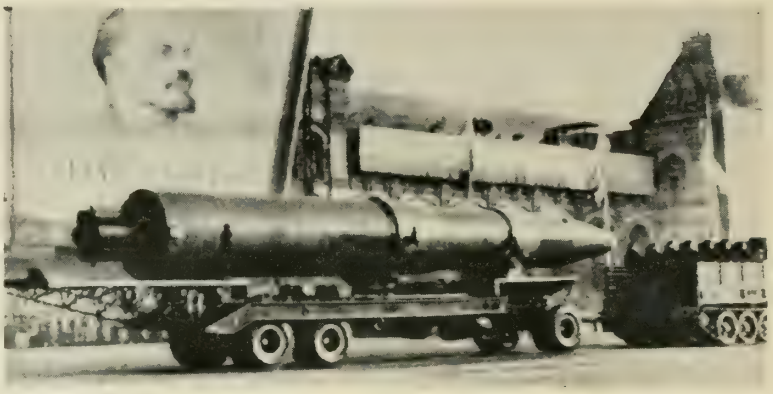
The White House announced last week that the International Assn. of Machinists has given Boeing Co. a no-strike pledge until Jan. 15. Before then the National Labor Relations Board will poll Boeing employees on the question of a union shop.

Boeing has agreed to the poll with the understanding that it will not be bound by the results.

The President's three-man Aerospace Board will make no recommendations on the dispute until the vote results are known, and its recommendations will have no weight under existing law. However, the Administration is expected to apply whatever pressures it can to back up the committee's suggestions.

Ryan Aeronautical Co. employees recently followed others at North American and General Dynamics in voting down the union shop. While a two-thirds vote was needed to establish the shop, only 60.4% favored the plan.

This was a blow to union officials, as over 70% of Ryan's employees were already union members.



## Russians Unveil New Shore-to-ship Missile

*THE RUSSIANS have revealed a new 50-ft. missile with a range of about 200 miles and designed for shore-to-ship use. The Soviet Navy weapon is shown here during a review held in Moscow Nov. 7. The familiar expansion nozzles seem to have been eliminated in this design or are concealed in the cylindrical exhaust tubes visible at the rear.*

## Shots of the Week

A *Nike-Hercules* rocket carried a low-yield (less than 20 kt) nuclear device to an altitude of 20-30 miles over Johnston Island Nov. 4, closing the U.S. nuclear test series in the Pacific. It was the 36th atmospheric or high-altitude test conducted by the U.S. since the test program began April 25.

Highly significant results were reportedly gained from the "Dominic" series, particularly in the areas of more efficient and radical warhead designs, improved yield-to-weight ratios, ballistic misssile defense, ballistic missile penetration of enemy defenses and disruption of electromagnetic defenses by nuclear detonations.

• *Mars I* was successfully launched by the Soviet Union, Nov. 2 (see story, this page).

• A second successful field firing of the solid-fueled *Sergeant* from White Sands Missile Range Nov. 2 was announced by the Army.

• The 16th Operation Firefly high-altitude rocket was successfully launched from Eglin AFB, Fla., Nov. 5. Using a *Nike-Cajun* rocket, the Firefly experiment created an artificial cloud at an altitude of 50 miles.

• *Polaris A-3* failed 30 sec. after its launch from a land pad at Cape Canaveral, Nov. 5. The failure was attributed to a booster malfunction. It was the fourth test of the advanced *Polaris*. Three previous tests were "partially successful."

• The Air Force attempted to launch a secret satellite into Polar orbit from Vandenberg AFB, Calif., Nov. 6. A *Thor-Agena* was used. No further details were released.

• The 150th *Atlas* to be fired was launched from Cape Canaveral, Nov. 7, more than 4000 miles down the Atlantic Missile Range. The *Atlas*, an "F" model, was launched by an Air Force crew in a test of its systems, subsystems and accuracy.

## NASA Reprograms Funds

NASA has advised Congress of plans to reprogram $10,426,000 in FY '63 funds to begin construction of facilities at White Sands Missile Range, N.M.

A major NASA expansion, the facilities will provide a needed land recovery area for flight testing the *Gemini* and *Apollo* spacecraft. An additional $375,000 from advance facilities planning and design funds is already available in the FY '63 budget for the WSMR facilities.

In a letter to the House Space Committee, NASA Administrator James E. Webb said that $1,717,000 was needed to construct a launch complex for the *Little Joe II* test vehicles to be used in ballistic tests of the *Apollo* spacecraft.

The remaining $9,084,000 of the reprogramed funds are to provide for site development and utilities, a spacecraft preparation building, spacecraft test stands, fuel storage, transfer and control facilities, project control facilities, instrumentation and design and engineering.

In another reprograming action, NASA told Congress an additional $7,655,000 was needed to support work by North American Aviation's Downey, Calif. plant. The money is earmarked for construction of a systems integration and checkout building, a space systems development facility, production, fabrication test and other equipment. NASA had previously reprogramed $2.3 million for these facilities.

## Gemini Tracking Modified

NASA has awarded contracts totaling $12 million to four firms for modifying the space agency's Project *Gemini* tracking network.

The four contracts will provide various world-wide NASA stations, tracking acquisition aids and digital radio frequency (RF) command systems.

Equipment and services to be provided are:

- Tracking antenna acquisition aid systems: Canoga Electronics Corp., Van Nuys, Calif., $1,045,500.
- Digital command encoders. Radiation, Inc., Melbourne, Fla., $1,950,000.
- RF command systems: Collins Radio Corp., Dallas, $1,725,000.
- PCM systems: Electro Mechanical Research Corp., Sarasota, Fla., $7,376,379.


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***Lunar orbit prevails . . .***

# Grumman Gets LEM Contract

***Apollo spacecraft team now complete; RCA, Rocketdyne reportedly in line for major subcontracts on module***

**by Hal Taylor**

NASA HAS FINALLY given the go-ahead to its Manned Lunar Landing program with selection of Grumman Aircraft Engineering Corp. to build the Lunar Excursion Module of the *Apollo* spacecraft.

Under terms of the contract, Grumman will build 25 of the two-man spacecraft, which will land the first U. S. astronauts on the Moon.

Ten or twelve will be flight vehicles with the remainder ground test models.

NASA officially estimated the value of the contract at about $350 million. This was based on Grumman's proposal to build 18 spacecraft. The addition of seven vehicles by NASA is expected, according to well informed sources, to bring the cost to close to $600 million.

Grumman's work on LEM will be performed at its Bethpage, N. Y., plant. NASA estimates that during the peak period 2500 to 3000 people will be employed. Some 1500 will be engineers.

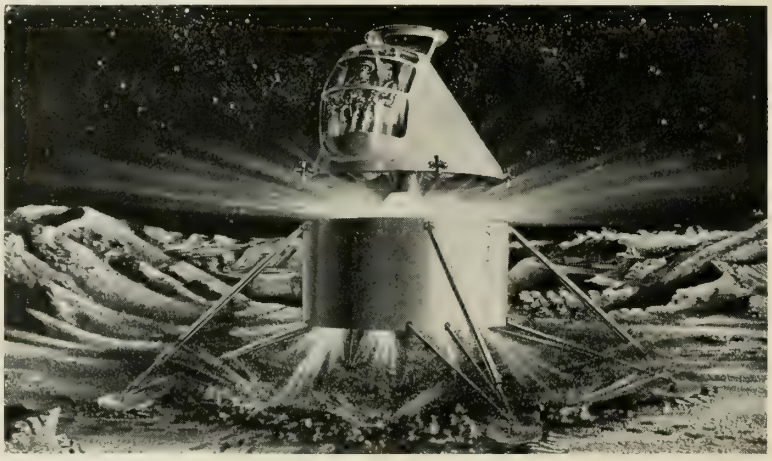
Informed sources report that Grumman has already selected two of its major contractors. RCA-Princeton will build the guidance and control, and the power system of the spacecraft. The Rocketdyne Division of North American Aviation Inc. reportedly will develop the spacecraft's propulsion unit.

Nine firms submitted bids for the LEM contract. In addition to Grumman, they included Lockheed Aircraft Corp., Boeing Co., Ling-Temco-Vought, Inc., Northrop Corp., Douglas Aircraft Co., General Dynamics, Republic Aviation Corp. and Martin Marietta Corp.

Selection of Grumman completes the *Apollo* spacecraft's contractor team. North American Aviation Inc.'s Space and Information Systems Division was named last November to develop the Command and Service modules.

The selection also settles a dispute within the Kennedy Administration on the method to be used to achieve the first manned lunar landing. NASA announced its decision to utilize orbit rendezvous in July, 1962.

The space agency continued to study alternate methods, including Earth orbit rendezvous and direct flight with a two-man spacecraft, while it evaluated the LEM bids. Although NASA remained firmly committed to LOR, it had to convince White House Science Advisor Jerome Wiesner and other officials within the Administration of its feasibility.



*LEM CONFIGURATION is indicated in this UTC artist's conception of module blasting off from Moon using UTC aeration throttling* *(see p. 31).*

• **Design shape** — NASA officials said that LEM will look something like the cab of a two-man helicopter. It will be 10 ft. in diameter and will stand about 10 ft. high with its skid type legs. During the trip to the Moon, it will weigh about 12 tons. Weight after launch from the Moon will be about 4 tons.

While final design has not been completed, NASA said that on-board LEM instrumentation will parallel that of the command module as much as possible. This is based on safety and redundancy requirements.

Development of the propulsion system will be one of the most difficult technical jobs involved in the LEM contract. The system's two engines will burn storable hypergolic fuel with a burning time of eight to ten minutes for each. The lunar touchdown engine will be throttleable over a thrust range of 1000 to 10,000 lbs. The lunar takeoff engine will have 4000 lbs. thrust.

LEM will detach from the three-man *Apollo* spacecraft's command and service modules while in lunar orbit. One astronaut will remain in orbit in the command and service modules with two pilots riding LEM down to the lunar surface. After launch from the lunar surface, LEM will dock with the orbiting modules. For the return trip, the three-man crew will return in the command module, using the service module propulsion, leaving LEM in lunar orbit. ⁂

## *Ad Astra Per . . .*

GRUMMAN'S victory in the LEM competition climaxed a three-year, $2-million drive to gain a spot in the lunar program.

The success grew out of the company's failure to win the initial *Apollo* contract. When that award was lost after an extended company-funded effort, Grumman decided to push ahead with its LEM proposal.

The LEM team under direction of Joseph Gavin, director of space projects, included: Robert S. Mullaney, program manager; William C. Rathke, engineering manager; and Thomas J. Kelly, project engineer.

***Dixon discloses . . .***

# Nova Will Need Huge Liquid Engine

## *NASA official also declares schedule now requires development and flight-test of fluorine space engine*

NASA is seriously considering development of a new liquid engine with thrust of 20 to 30 million lbs. for the *Nova* superbooster.

Deputy Associate Administrator Thomas F. Dixon reports that the space agency will launch conceptual studies of the big rocket engine in the near future.

Dixon told a joint Army-Air Force-Navy-NASA-ARPA Liquid Propulsion Symposium in San Francisco that *Nova* will very likely require a much larger liquid rocket engine than the F-1.

"The first stage of *Nova,* in one of several configurations now under study, requires one new liquid rocket engine with a thrust of about 20 to 30 million lbs.," Dixon said. "An engine of this size calls for some departure from the present engine configurations, particularly with regard to the thrust chamber.

"*Nova* is not the end of the road for large chemical rocket boosters," he told the liquid propulsion experts. "There are even larger engines under consideration by advance planners."

In other major points, Dixon told the group that:

—It is time to develop and flight-test an engine which will use fluorine in space missions.

—Five problem areas confront the liquid propulsion industry—damaging combustion oscillations, the suitable use of hydrogen as a fuel, propulsion operation in the space environment, use of ablative materials for the thrust chamber, and thrust control.

• **Choice of three**—It is understood that the large engine is one of three possible configurations for the *Nova* first stage which are being considered by NASA and its industrial study contractors, Martin Marietta Corp. and General Dynamics/Astronautics.

The other possibilities are the mating of 12 F-1 liquid oxygen engines or four 260-in. solid motors. The F-1 is already in an advanced development stage, but work on the big solid motor has not been initiated by Dept. of Defense.

Dixon told the group that it takes 8 to 10 years to bring a large rocket engine from concept to flight readiness in a large booster for manned flight. A number of research projects are already under way in NASA's propulsion program, and are making progress.

"These studies will assess current work on advanced propulsion concepts and point out areas where new concepts need to be investigated," he added.

Dixon pointed out that studies for the super-rocket engine concept must be undertaken if the "man-rated" engine is to be ready within the long lead-time required. He said many months of intensive research are required before development could be possible.

Radical new designs are required for engines in the 20-to-30-million-lb. class. Scaled up to produce that thrust, the F-1 engine—the largest now under development—would measure almost 70 ft. high and 45 ft. across the nozzle.

More compact engines of this thrust level could result from new thrust chamber and nozzle configurations now under study. These nozzle concepts utilize principles that expand the gas with much more compact nozzle shapes than the conventional cones or bells.

Turning to the fluorine engine, the NASA official said future missions will require propulsion systems delivering high velocity and high performance.

"For these, fluorine as an oxidizer is of interest in chemical propulsion systems. We must discover new high-energy propellant combinations, beyond hydrogen fluorine, diborane, oxygen, difluoride, and beryllium-oxygen-hydrogen."

He said the problem is to identify promising combinations, determine their physical and chemical properties, calculate their performance and experimentally determine their combustion, heat-transfer and expansion characteristics.

"What remains to be done with this combination is to build and fly an experimental engine that will demonstrate the feasibility of using fluorine in space missions. We are hopeful that this can be done," he said. ⌗

## *Apollo Crews To Have Minimal Shielding*

GATLINBURG, TENN.—*Apollo* astronauts will venture to the Moon with little more radiation protection than that provided by the hull of their space ship.

The men will have special protection only for their eyes. Neither the Lunar Excursion Module nor the *Apollo* spacecraft will carry special shielding, according to William L. Gill of NASA's Manned Spacecraft Center.

Gill, chief of MSC's crew systems division radiation branch, gave this forecast to 500 scientists gathered here for a symposium on protection against radiation hazards in space. He also revealed radiation dose rates that were higher than expected.

Astronauts will be allowed yearly dose rates of 233 rads on the skin, 54 to blood-forming organs, 599 to the feet, ankles, and hands, and 27 to the eyes.

Maximum single radiations: skin, 500; blood organs, 200; feet, ankles, hands, 700; eyes, 100.

Gill said the dose rates would be controversial, but declared they were worked out with Oak Ridge National Laboratory.

The walls of the *Apollo* spaceship will provide most of the shielding. The honeycomb sandwich of aluminum will have a mass of 1.5 grams per square centimeter, as recommended this week by North American Aviation. Gill said this would be close to the minimum shielding and probably would be increased. No special glass or plastic will be used on the windows, he said, but devices to provide local shielding for the eyes will be worn by the crewmen.

Gill said studies of the last solar cycle indicated the peak radiation encountered by a Moon-bound spacecraft would be about $10^{92}$ or $10^{102}$ particles of energies more than 20 million electron volts. Below this energy level, Gill said, NASA was not worried about the radiation penetration of the spacecraft.

Much testing remains to be done, he said, on locating equipment around the *Apollo* spacecraft to derive maximum shielding from the spacecraft instruments.

# NASA Missions Through 1980 Outlined

## *Mars station, manned Jupiter and Mercury satellites seen if budget allows, Hyatt tells Chicago meeting*

A TOP space agency planner has detailed possible future NASA space missions through 1980—including a Mars station and manned satellites orbiting Jupiter and Mercury.

Abraham Hyatt, director of NASA's Office of Plans and Program Evaluation, emphasized that all of NASA's planned manned missions beyond 1968 are only in the preliminary analytic study phase.

He said the speed with which they are attempted will depend upon budgetary limitations and the time and energy barriers of space.

Among the possible post-*Apollo* missions, Hyatt listed manned orbiting labs, an operational ferry vehicle, recoverable boosters, a lunar station, manned Mars expeditions, a Venus reconnaissance and the search for life on the planets.

The breakdown of what may be NASA's space programs of the future was delivered by Hyatt to the NASA-University Conference on the Science and Technology of Space Explorations, held in Chicago.

Representatives of more than 300 universities heard a host of NASA scientists and officials report on all aspects of space agency research and development activity.

Homer E. Newell, director of the Office of Space Sciences, made a plea for a scientific exploration program utilizing unmanned satellites.

Newell's statement is especially important because of the tug of war over budgetary funds going on between NASA's manned space flight and unmanned scientific exploration programs.

Rejecting any tailoring of the scientific program to the needs of Project *Apollo*, Newell declared that the engineer searching for data needs a broad, well balanced space sciences program.

• **Budget breakdown**—NASA's Director of Administration Albert F. Siepert reported that the agency's Fiscal '63 R&D budget of nearly $3 billion will include $1.088 billion for launch vehicles, $1.190 billion for spacecraft, $135 milllion for tracking and data acquisition, and $528 million for R&D activities of NASA personnel and centers.

The office of space sciences is earmarked for $601 million, including $198 million for scientific satellites and research, $232 million for lunar and planetary unmanned spacecraft, $125 million for launch vehicles and $48 million for advanced technology.

In the field of applications, $64 million will be spent on meteorological satellites and $48 million for communications satellites.

• **Conical approach**—Interplanetary spacecraft should be shaped like a large-angle cone and enter the atmosphere point first, said H. Julian Allen, assistant director of the Ames Research Center and originator of the blunt end first re-entry shape of Projects *Mercury* and *Gemini*.

Allen told the educators that "conical bodies deserve consideration because radiation heating increases drastically at the entry speeds involved in planetary travel."

The conference also heard:

• A prediction that in the years ahead, half of the materials used in every space vehicle will be non-metallic. Dr. George F. Pezdirtz also cited growing interest in the use of polymers for spacecraft materials.

• A report that NASA support of universities will more than double in Fiscal 1963, jumping to $80 to $100 million compared to $40 million in Fiscal 1962. Included in the current fiscal year's funding is $15 million for the training grant program, $10 million for research facilities, $5 million for special purpose research grants, and $40 to $70 million for project research in universities.

• A proposal that Mars be made an ecological preserve where steps are taken to protect the planet from undesirable contamination. Mars would be investigated in such a manner as to protect the interests and needs of the biologists who wish to search for and study any living forms or traces of life that might exist there. ⁂

**SOME SPACE EXPLORATION POSSIBILITIES**

| MISSIONS | EARTH ORBITS | REGION LUNAR | PLANETARY |
|---|---|---|---|
| | 1958 | 1962-68 | 1962 |
| UNMANNED | UNMANNED SATELLITES<br>SCIENTIFIC SATELLITES<br>Small Special Purposes<br>Small Orbiting Observatories<br>APPLICATION SATELLITES<br>Communication<br>Meteorology<br>Navigation<br>Engineering Research | LUNAR PROBES<br>RANGER<br>Surveyor<br><br>Intermediate<br>Space Probes | DEEP SPACE PROBES<br>MARINER<br>Voyager<br>Search for Extraterrestrial Life<br>Out of Ecliptic<br>Gravitational Experiment<br>Outer Planets and their Satellites<br>Leave Solar System |
| MANNED DEVELOPMENTAL | 1962-68<br>MANNED SATELLITES<br>BALLISTIC RE-ENTRY<br>Mercury<br>Gemini<br>Maneuvring Re-entry Interim Orbital Labs | Before 1970<br>MANNED LANDING<br>Apollo<br>Lunar Logistic System | After 1975<br>MANNED EXPEDITIONS<br>Mars Landing<br>Venus Reconnaissance<br>Search for life on planets<br>NO AUTHORIZED PROGRAMS YET |
| MANNED OPERATIONAL | AFTER 1968<br>ORBITAL OPERATIONS<br>MANNED ORBITING LABS.<br>Operational Ferry Vehicle<br>Recoverable Boosters<br>Engineering Experiment and Development<br>NO AUTHORIZED PROGRAMS YET | AFTER 1970<br>LUNAR STATION<br>Scientific Observations<br>Lunar Explorations<br>NO AUTHORIZED PROGRAMS YET | AFTER 1980<br>PLANETARY OPERATIONS<br>Mars Station<br>Advanced Manned Exp.<br>Jupiter Satellites<br>Mercury<br>Others<br>NO AUTHORIZED PROGRAMS YET |

*RECENTLY-RELEASED NASA table of projected missions through 1980.*

***Brown, Rubel speak out . . .***

# DOD Defends Centralized Management

**by Don Zylstra**

TOP PENTAGON officials charged both industry and the military services last week with failure to live up to their responsibilities in program management.

This, they said, is a major reason behind the increasing centralization of authority in the Dept. of Defense.

Dr. Harold Brown, Director of Defense Research and Engineering, asserted in a MISSILES AND ROCKETS interview that the military services are unable to determine which programs they are willing to give up in order to clear the way for new projects.

At the same time, Brown's principal deputy, Asst. Secretary John H. Rubel, told a Washington conference that increasing management emphasis and all that it implies—cost consciousness, cost reduction, better programing, better utilization of personnel—is going to continue and even to accelerate within DOD.

This trend toward centralization Rubel blamed on the failure of the industry-government team to produce useful weapons with sensible lead-times, optimum use of personnel, control of design changes and within the programed development funds.

• **Brown voices views** — Although admitting that the military services cannot be expected "to be critical of programs already started, particularly when new things they want seem to depend on things they already have going," Brown pointed out that, unless there is a willingness to cancel older projects, only a very limited number of new programs can be started.

Once the decision has been made as to what is important, Brown said, funds can be made available through reprograming or other actions to support a new program. More important than funds, however, are competent people to conduct programs—and they are usually in short supply.

Brown also emphasized the flexibility of the program packaging concept. Routine practice, in both the present Administration and its predecessor, has shown a constant stream of program changes from the services. In fact, Brown emphasized that between 10% and 15% of funds allocated for force structure hardware and R&D may be reprogramed in a typical fiscal year.

"The main value of a five-year projection of force strengths and development needs is to indicate which type of things may be competing to fulfill the same function, which types of hardware or R&D would be duplications. It is becoming increasingly important for service staffs to project their needs.

"The bigger the total budget for an armed service, or agency, or program, the harder it is to justify additions, rather than substitutions. A program or agency of the Defense Department with a budget of only a relatively few thousand dollars may be more readily justified in asking for a doubling or other major increase in its budget than the one in which millions or billions are involved," Brown asserted.

"If, for instance, there were a proposal to increase R&D funding from $7 billion to $14 billion, what the proponents of such a move would really be saying is that they don't know what is most important," he said.

Noting that DDR&E is often criticized for prolonged study of new proposals, Brown said that his office is often as concerned about beginning development of a simple, workable weapons system as the military services.

"The allegation is that we may thus produce a more efficient weapon too late," he noted, "whereas the armed forces would be happier with a less perfect weapon sooner. Often quite the reverse is the case."

Many times DDR&E has resisted the military's tendency to complicated systems in favor of something more workable than can be deployed sooner, Brown said. His office sometimes has urged the adaptation of a weapons system to a change in function or mission —one it can more easily perform— rather than to design prematurely for a more sophisticated function with less chance of success.

• **Rubel follows boss**—Four of the major objectives of DOD—and four of its major problems in the development of weapons systems—were outlined by Asst. Secretary Rubel. They are:

—Development of weapons and equipment that the fighting man can use.

—Attainment of reasonable lead-times.

—Optimum use of limited scientific and engineering manpower resources.

—Effective cost controls and improved cost forecasting with the virtual elimination of cost overruns.

Cost overruns—often ranging from 300 to 1000 percent—have made it almost impossible to plan realistically and with confidence for the future allocation of R&D resources, Rubel said. Therefore control and more accurate prediction of costs is an important objective in DOD. ⌗

## *Missile B* Work To Be Done In Detroit

CHANCE VOUGHT Corp., a division of Ling-Temco-Vought, Inc., has been awarded an estimated $100-million contract for the development and initial production of *Missile B*.

Chance Vought Corp., a division of Ling-Temco-Vought, Inc., was awarded an estimated $100-million contract for the development and initial production of *Missile B*.

The Army announced that the Dallas firm would perform the work in the Warren Ordnance Plant near Detroit. Chrysler Corp., which lost out in the *Missile B* competition, previously had occupied the 2-million-sq.-ft. plant.

Chance Vought and Chrysler were selected in August to perform program definition studies for the mobile missile system. These were submitted to the Army Missile Command on Oct. 22. Selection of Chance Vought was announced 10 days later.

• **Guidance concept new**—*Missile B* will give the Army a material increase in both the range and accuracy of *Honest John* and *Lacrosse* —the two systems it is to replace. The primary contributor to this increased accuracy is the Autonet guidance system, which is described by the Army as a "radical simplification" of previous guidance.

Autonet requires substantially fewer parts than present guidance systems and is more closely integrated with propulsion—resulting in a lower-cost, more reliable, more maintainable and more rugged missile (M/R, Aug. 20, p. 18).

• **Development plans**—The development of *Missile B* is expected to take four years with the first unit being operational in late 1966. Production plans are classified, but estimates have been made that as many as 1500 will be made.

*At NEREM meeting . . .*

# IR Touted for Equipment Evaluation

***Fifteen firms at work on exploiting promise of technique for improving design, cutting failures***

**by Mike Getler**

BOSTON—Interest is growing steadily in the application of infrared techniques to a wide range of reliability and process control programs.

In a paper presented here last week at the 16th Northeast Electronics Research and Engineering Meeting (NEREM), Dr. Riccardo Vanzetti, quality assurance manager with Raytheon's communications and data processing operation, predicted that IR test methods would improve equipment design, reduce failure rates, allow prediction of component failures within a system, and lead to a rapid and fully automated system check-out process. In essence, he said, IR may add a new dimension to electronic equipment evaluation.

Vanzetti is also technical director of a newly formed industry group, composed of 15 major aerospace and electronics firms, charged with developing both a broad technical base in this field and a detailed applications program for specific needs.

• **NEREM '62**—Nearly 20,000 attendees were expected at this year's NEREM; however, registrations during the first two days of the 3-day meeting showed that early estimates were overly optimistic. Several NEREM officials felt that high interest in last week's national election had a marked effect on conference participation.

Over 325 exhibitors jammed Boston's Commonwealth Armory. Typical of past NEREM shows, exhibits were dominated by small components and test equipment, reflecting New England's growing interest in, and diversity of, electronic manufacturing. In the 25 well attended technical sessions, held at the Armory and at The Somerset hotel, over 100 papers were delivered.

• **IR approach promising**—Though a few firms have already made individual attempts at using IR in evaluation of equipment, there is now a new and concerted effort supported by more than a dozen firms to greatly expand what is generally considered to be a highly promising approach to electronic component and systems reliability.

Essentially, the approach utilizes the correlations between component heat dissipation, the associated IR radiation level, and current flow through the unit. Though many of the correlations reflect basic physical laws, many variables recently observed in tests are not yet completely understood.

Using IR radiometers and other IR sensing equipment, there is no physical contact between the test equipment and the component being tested. Therein lies what should prove to be a major advantage for IR systems over more conventional ammeter and wattmeter devices. IR advocates claim these conventional test methods tend to introduce unwanted loads, disturb electrical or thermal operating equilibrium, and are often difficult to connect with extremely small or inaccessible circuit components. The latter problem could become especially acute with the introduction of more thin-film and microminiaturized circuitry.

As an example, NASA is reportedly interested in development of an IR microscope to read thin-film circuit current. The space agency is also said to be interested in extremely high reliability non-destructive IR test equipment to check welded or soldered circuit connections.

Vanzetti estimates that within a year test results will bring an acknowledgement that these IR techniques are successful in weeding out a wide range of electronic failures.

## Sperry Claims Laser Gain

Scientists at Sperry-Rand's electronic tube division are claiming a major advance in laser technology has been achieved with development of a system which will allow single-frequency outputs and beam angles of 1/200 of a degree from any laser.

Though they have not yet achieved this single-frequency output, scientists report they have reduced the number of frequencies from 200 to four and hope "in the near future" to reach the single-frequency goal. To get the desired oscillation, engineers installed a small disc-shaped frequency filter, called a Fabry-Perot etalon, between the ruby and one of the transparent output mirrors of an experimental laser at the laboratory.

• **New needs**—Though major gains have been made in recent years on IR measurement and detection equipment, Vanzetti feels new equipment will be needed—simpler and less bulky, with perhaps even less sensitivity than some of the units now available.

New IR sensing and recording equipment, with fast time responses, able to read in the 7-10 micron bandpass and also able to measure the recombination IR energy in the 2-micron region, will be required. Rapid scanning equipment will be needed. Sensitivities of at least 0.01°C, already within the state of the art, will be required.

Vanzetti reports that widespread acceptance of these methods also will lead to new component product lines, particularly in the development of IR transparent semiconductor encapsulation to allow reading of the thermal effects at the semicon junction, considered to be a key factor in the life span of these devices.

In an extensive test series now going on at Raytheon, using Barnes Engineering Co. radiometers, Vanzetti reports radiometer/recorder measurements on a string of 2-watt resistors indicates 10-15 milliwatts difference in heat dissipation can be identified. He estimates sensitivities to 1 milliwatt may be possible.

In tests with epoxy-covered diodes, differences have been measured to 0.012 milliwatt, which Vanzetti claims is far beyond early expectations.

Though it is still in the early stages, Vanzetti theorizes that development of an IR characteristic pattern for components could be accomplished. With all failure patterns simulated and stored in a memory, faults could be quickly isolated in a completely automated rapid systems test. He also feels the IR picture may replace the schematic in the failure, allowing technicians to take and compare an IR photo of a troubled unit with one showing the pattern of a correctly operating unit.

Leonard L. Fagin, quality control manager at Barnes Engineering Co., a leader in development of IR devices, also stressed the importance of the techniques at the Chemtronics conference in New York earlier this month. ⌗

# Laser Tracking To Get Boost in S-66

## *Goddard-developed experiment with GE reflector slated for early launch; novel acquisition system used*

A GIANT STEP toward a laser-tracking system for spacecraft may come from an experiment on board the S-66 *Polar Beacon Ionosphere Satellite* scheduled for launch early next year.

Data from the experiment could yield a means vastly more accurate than Minitrack for determining trajectories and orbits. Only passive assistance is required from the tracked spacecraft.

Originators of the laser experiment —Dr. Henry H. Plotkin and his assistant Thomas S. Johnson, scientists at NASA's Goddard Space Flight Center— gave the first technical details of their work Nov. 8 at the Ohio State University Symposium on lasers and applications.

Earlier, Johnson told MISSILES AND ROCKETS the experiment may have applications extending beyond the tracking concept—possibly leading to very-wide-band communications.

• **Concept**—For the experiment, a pulsed ruby laser mounted on a tracking telescope will be aimed at the *S-66* (M/R, Aug. 6, p. 22). The light reflected by corner reflectors on the satellite will be detected by a photomultiplier tube or other sensor. The detected signal will then be used for ranging purposes or to generate servo-drive error signals.

The optical reflector is described as composed of a mosaic made of cubed corners of fused silica, each about one in. across. The light incident on the satellite will be reflected with a divergence of $10^{-4}$ radians. The reflector assembly is being fabricated for Goddard by General Electric-MSVD, which is to supply a prototype ground transmitter and sensor.

To measure the time of flight, a pulse from the laser transmitter is used to trigger a delayed sweep and the received pulse is displayed on a scope. The known sweep delay plus the position of the pip gives the time interval.

In a discussion of the order-of-magnitude of the signal, Plotkin and Johnson assumed: pulse energy, 1 joule; atmospheric transmission, 0.8; reflector efficiency, 0.5; reflector effective area, 200 cm$^2$; telescope aperture 500 cm$^2$; transmitter bandwidth, 1 milliradian; reflector divergence, 0.1 milliradian; and range, 1500 km.

The resulting signal, they say, should be more than adequate for photoelectric detection at night, and perhaps usable even in daylight. "We are hopeful that a photographic picture can be recorded of the reflected flashes against a star background by increasing the laser pulse power and using a larger-aperture ballistic camera."

The authors pointed out that the most difficult feature of this exercise will be acquiring the target within the milliradian laser beam width. To help solve this problem, they are developing a unique system: as before, the laser is mounted on a tracking telescope. Now, though, "the sensor is a sensitive image orthicon whose information is stored in a digital computer. By sensing the deviation of the target from the optical line of sight, a servo error signal is generated to drive the telescope accurately on the target. The angle readout from shaft encoders is expected to be accurate to 5 seconds of arc."

In actual operation, the telescope begins to drive along a predicted trajectory inserted into the computer. When the target is acquired, error signals correct the predicted orbit and achieve lock-on. Chances for successful acquisition depend on the accuracy of the orbit generated from previous radio and optical tracking data. ⌘

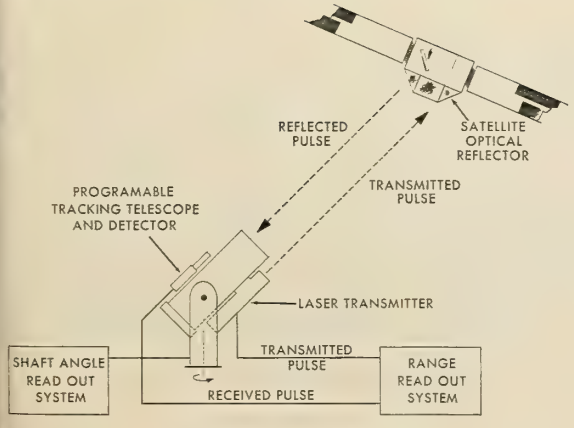
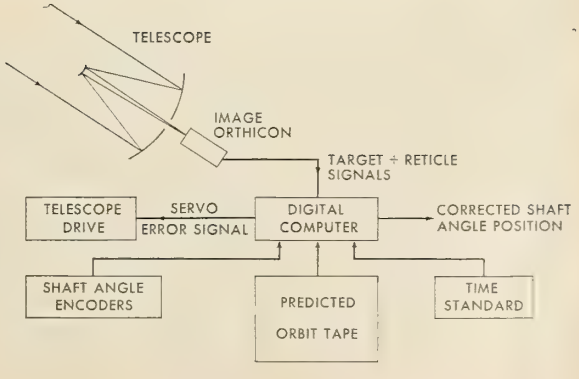



*DIAGRAM of laser satellite tracking experiment.*




*REAL-TIME automatic digital optical tracker.*




# PRECISION POWER on these sites is a must . . . and

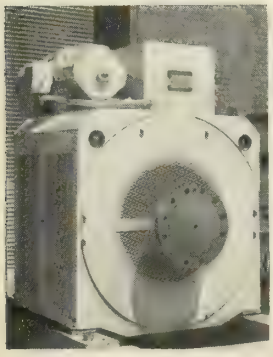
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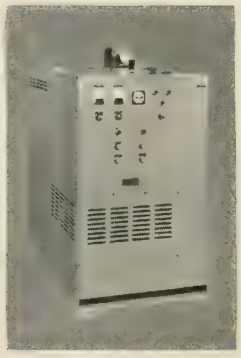
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# Technical Countdown

## ELECTRONICS

### Light-Emitting Diode Developed by Philco

A diffused-junction gallium-arsenide diode which emits monochromatic light near 9000° A when forward biased is commercially available from Philco Corp. The intensity of emitted radiation can be controlled by suitable variation of the bias current, making it possible to obtain monochromatic light modulated at frequencies extending into the microwave region. The required modulation power is only a few tenths of a watt, and radiated power outputs of more than 1 mw are obtainable at room temperature operation with more than 25 mw of output power available when the diode is cooled to 77° K. The GAE-402 can be used, says Philco, in conjunction with any suitable light-detecting device to form a solid-state optical communications system. The efficiency of the emitting material is estimated to be 5% at room temperature with 100% possible at 77° K, developers claim.

### U.K. to Test Monster Tube

The world's largest thermionic tube, measuring 18 x 7 x 6 ft. and weighing 4½ tons, has been built by the British Admiralty's Services Electronic Research Laboratory at Harlow. To be used by Marconi Instrument Co. for space radar research, the tube is expected to produce a 100-mw output beam. Extensive shielding will be required, reportedly, to provide personnel protection against hazardous X rays radiated by the tube.

### SLAR Distortions Can Be Corrected

A "restitutor" which is now under test by the Army will permit planimetric mapping from radar photography to a scale of 1:250,000. Believed first of its kind capable of rectifying photographs obtained from side-looking radar, the system was developed by Belock Instrument Corp. for the U.S. Army Engineer Geodesy, Intelligence and Mapping R&D Agency. The instrument corrects all imagery for slant range and minor systems distortions and repositions imagery with respect to adjusted aircraft flight lines. The output is a geometrically correct 9½-in. film strip of the original radar presentation.

### Computer Recorder Leased to NASA

General Dynamics/Electronics is installing an S-C 4020 high-speed computer recording system at the Data Reduction Branch of NASA's Computation Center at Huntsville, Ala. The unit will speed the time involved in converting data from spacecraft instrumentation into graph forms for interested engineers. Cutting the conversion time from days to hours, the system displays information in graph and alphanumeric form on the face of a Charactron (R) shaped beam tube. Data are then projected through optical systems to a high-speed 35-mm camera.

### OAO Gets Automatic Charging System

An automatic electrical charging system for the *Orbiting Astronomical Observatory* scheduled for launching by NASA in 1964 has been developed by Bendix Corp.'s Red Bank Div. The system, consisting of battery-regulator-charger circuits and a sequence controller, will charge each battery in the satellite through a separate subsystem including sensing and control circuits. The charging operation operates automatically and a detector switches the solar-cell-gathered power from each charged battery to the next one in sequence. Sequence control can operate independently from a ground station, but command signals from a ground station override the automatic system.

## ADVANCED MATERIALS

### Re-Entry Simulation at Chance-Vought

Materials candidates for the *Dyna-Soar (X-20)* nose cap are being checked out in a 5000°+ F oxy-propane torch at Chance-Vought Div., Ling-Temco-Vought. Flames from 30 welder's torches are fed into a zirconia shroud containing the nose cap specimens. A converging-diverging nozzle feeds radiant energy back into the nose cap, properly distributing temperature from the cap stagnation point to the skirt. Temperatures are measured optically through seven inspection points and high-temperature runs can last as long as an hour.

### Fast Extrusion Press For Nuclear Metals

A Baldwin-Lima-Hamilton 1400-ton extrusion press with a maximum ram speed of 1500 ipm is in operation at Nuclear Metals, Inc. The press can also maintain constant speeds in the ranges below 100 ipm. Nuclear Metals will use the press in investigations into methods for drawing structural shapes with the high dimensional tolerances required for advanced airframe and missile applications. Other Air Force programs involved include the development of dies and materials for refractory metal extrusions.

### Radiation-Induced Opaqueness Researched

Preliminary experiments in the laboratories at Climax Molybdenum Co. are revealing that small amounts of certain moly compounds in an acrylic plastic causes the plastic to turn blue when placed in a beam of light, and revert when removed from the light. Although the reversible photosensitivity of acid molybdate solutions has been known for more than a century, interest is being revived in glass and other transparent materials that will automatically tint when exposed to radiation sources. Spacecraft observation ports are an obvious application.

### Economy Plasma Generator at Stanford

PIPER, Pulsed Intense Plasma for Exploratory Research, is in operation at Stanford University. Designed and built in one month by Dr. Richard Geller of France's atomic energy establishment (CEA), the unit consists of two opposing electron-gun beams mounted at each end of a 6-ft. glass tube. Hydrogen, argon or any other gas is fed into the tube, which is surrounded by a 2000-gauss magnetic field. Generated plasma ranges from 100,000° to 200,000° F, with charge density rises to $10^{14}$ electrons per cc. The poor man's plasma machine will be used for basic noise and instability studies.

# Piggyback Payload Designed, Shipped in Only 20 Days




by William Beller

GODDARD SPACE FLIGHT Center engineers recently conceived, instrumented and shipped a 200-lb. payload—in just 20 days—to meet the launch schedule for a scientific satellite.

The experiment was sent up Sept. 29 along with the *Alouette* satellite (S-27)—a joint U.S. and Canadian project. (M/R, Sept. 24, p. 35.)

Results of the Goddard experiment, revealed last week, are of exceedingly high quality. They indicate how very quickly an efficient payload can be put together to satisfy a sudden need—and perhaps how quickly a military payload can be devised to meet a precipitating national emergency.

• **Background**—Goddard's Test and Evaluation Group was told Aug. 10 that it could put exactly 200 lbs. of payload—with specified volume and moments of inertia—on board with *Alouette* if the completed package could be delivered to the Pacific Missile Range no later than Aug. 30. Object of the experiment: learn the vibration and acceleration environment of spacecraft during launch by a *Thor-Agena* vehicle.

This was the first time Goddard was using the *Thor-Agena,* and the engineers expected to be using it again. They wanted, therefore, to determine the vibration spectrum of the spacecraft in order to design future experiments and structure more efficiently.

The T&E Group tests all Goddard spacecraft to see whether they withstand vibrations and accelerations in flight—and whether they meet the 95% confidence level. On spacecraft using *Delta* launch vehicles, for instance, Goddard has chalked up a perfect score: 13 successes in 13 flights.

The *Alouette*-connected experiment became an all-Goddard project—not strictly one for T&E—because of the interface problems that had to be worked out. Spearheading the effort: James A. Nagy, 34, instrumentation engineer, Structural Dynamics Branch; Robert Pincus, 27, telemetry engineer, Sounding Rocket Branch; Carl L. Wagner, Jr., 34, aerospace engineer, Mechanical Systems Branch.

In 11 days the payload known as *TAVE—Thor-Agena Vibration Experiment*—was designed, built and ready for testing. Three days later, testing was finished and *TAVE* qualified for flight. In the remaining period while *TAVE* was awaiting shipment, final calibrations were performed. By the end of the allotted 20-day period the payload was ready to be mated to *Thor-Agena* at PMR.

• **Experimental results**—Vibration data taken during *Thor-Agena's* launch phase verified that the *Thor* has a thrust resonance at low frequencies. The experiment established, moreover, the transmissibility of vibrations through the *Agena* stage into spacecraft interfaces.

Of considerable theoretical importance was the fact that the experiment also verified the vibration analysis methods used both by Goddard engineers and by engineers at Lockheed Aircraft Corp.—builder of the *Agena* stage. This means the methods used can be relied on to give accurate results for future launches of similar configurations.

There was additional information from the experiment: immediately after main-engine cut-off—during a coast phase—a structural resonance in the thrust direction was found. The amp-

*VIBRATION experiment (TAVE) lowered on spin table.*



*INSTRUMENTS strung along TAVE periphery for high inertia.*

litudes damped out quickly, but they did indicate a possible source of harmful vibrations under different loading conditions.

"I suspect this is the highest quality data ever to come out of (launch-vehicle) flight measurements," John C. New, head of the T&E Group told MISSILES AND ROCKETS. "It is significant that the experiment was run by a group of people fairly young in our organization."

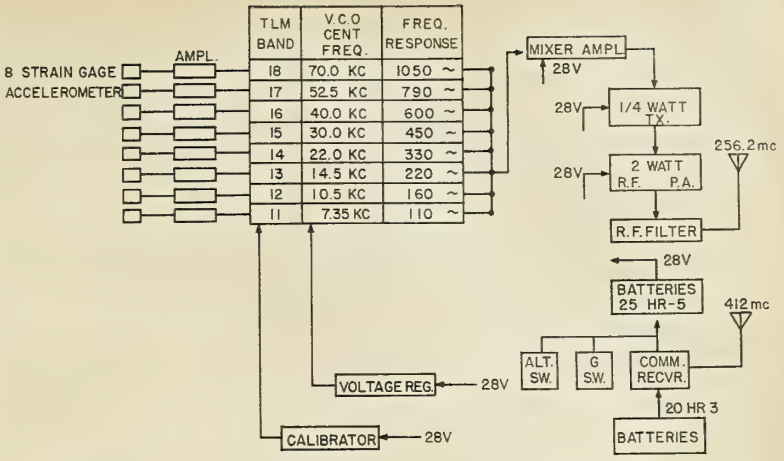
New added that the tendency is to rely on an established cadre of people to do a job. "We must broaden our base, however," he said, "and use our staff to guide—and then let the engineers proceed by themselves." He called for less paper work and progress reports and "more beds in the basement." New was referring to the round-the-clock work performed by the *TAVE* team, and their sleeping in temporary quarters provided by Goddard.

• **Design of experiment**—The launch and trajectory characteristics for the *Alouette* spacecraft had been set up more than a year before the scheduled firing date. When for some reason part of the payload was not forthcoming, its space had to be taken up by another mass of identical static and dynamic characteristics.

The *Thor-Agena* subsequently contained two payloads: the *S-27 Alouette* on top and *TAVE* below it.

To meet requirements of very high moments of inertia together with relatively low weight, *TAVE* was shaped into a cylinder having very thick walls but practically no weight in the center. The spin moment-of-inertia of approximately 10 slug-ft.$^2$ was the governing one.

The walls were attached to a central thrust tube by means of two sheet-metal cones. To maintain the high moment-of-inertia, however, the experiments were




*TAVE circuitry showing strain-gage transducers, telemetry bands.*

attached along the periphery of the thick cylindrical wall and above the upper cone. The structure had to be stiff for adequate frequency control—more than 50 cps. Final tests showed the natural frequency was higher than 200 cps. The dynamic balance ended up at 34-oz.-in.$^2$.

• **No room for error**—Once *TAVE* was installed in *Thor-Agena*, there was no way except by breaking up the vehicle to get at the experiment. One of the conditions for putting *TAVE* on board was that it would be independent of any other equipment present. The spin table on which *TAVE* was mounted prevented even an umbilical being used.

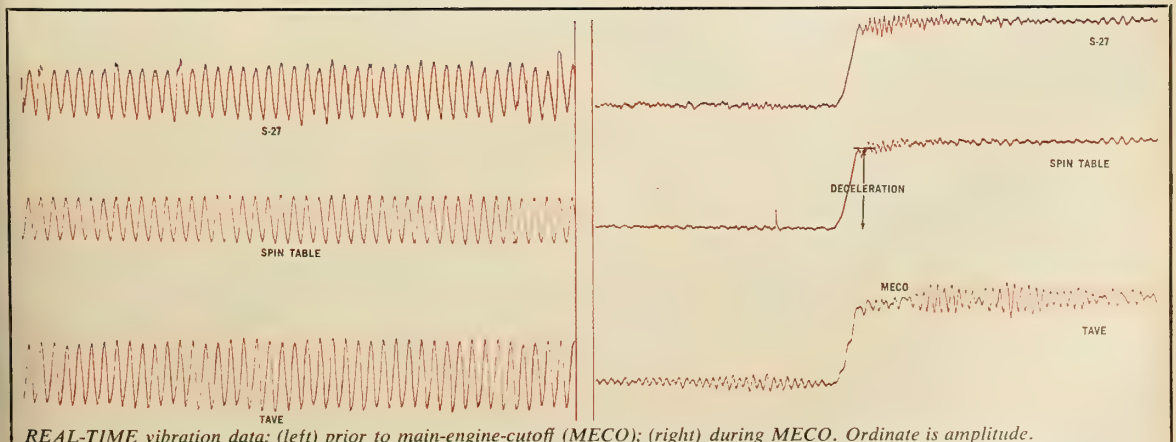
This meant that the *TAVE* command-receiver for turning on the transducer circuitry had to run on batteries for the four-hour check-out period prior to launch; if a long hold developed, the batteries might run down. Thus a back-up had to be used.

The experimenters were most eager to have the instruments operating immediately prior to launch in order to get lift-off information. Hopefully, the vibration and acceleration data would continue coming in throughout the launch phase.

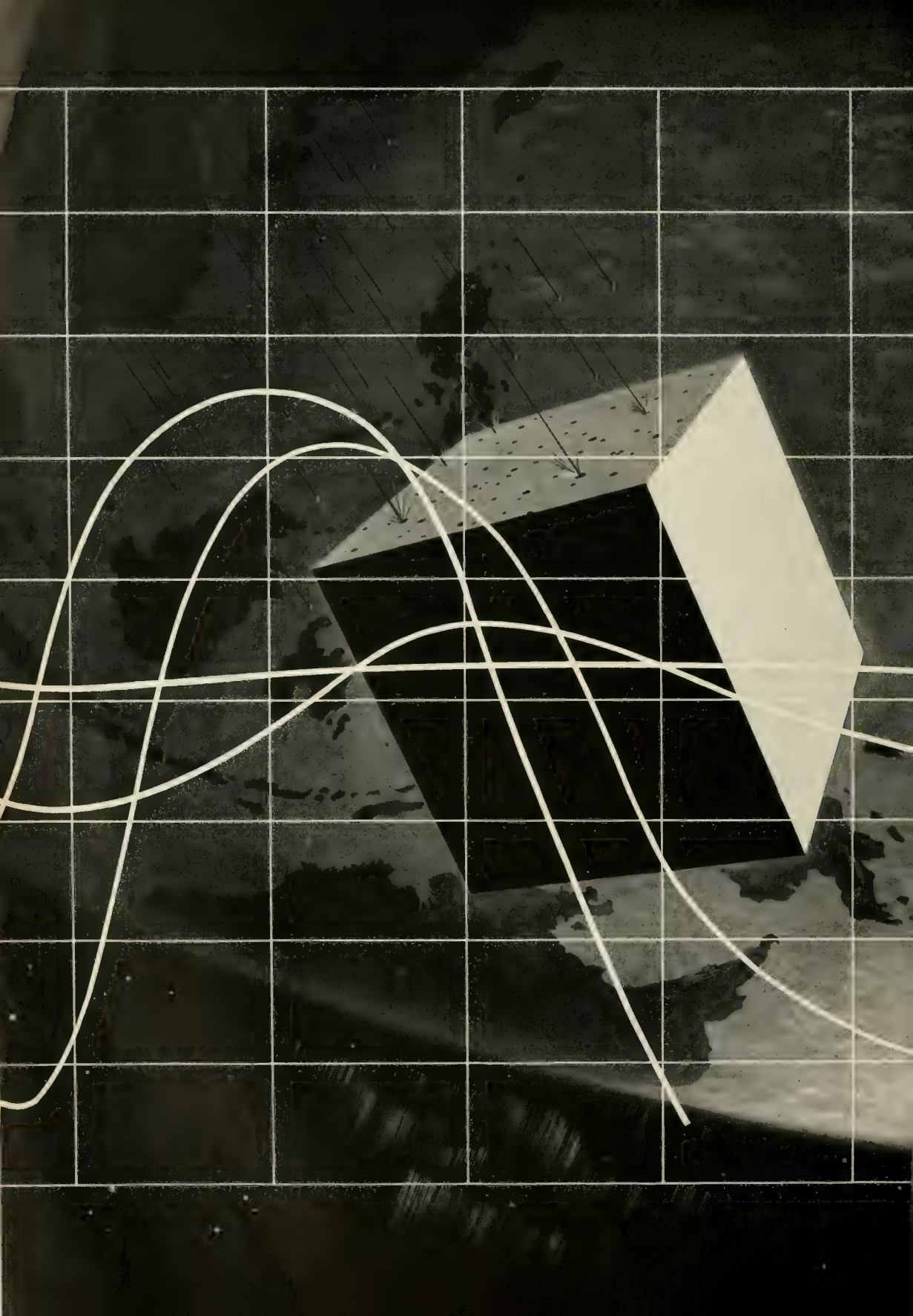
Eight strain-gage accelerometers mounted in lateral and longitudinal directions were the transducers used to gather the data. Locations of the transducers: on the *S-27* interface, *TAVE* payload, and spin table.

Sensitive inertia g-switches were the back-up to the command receiver. These switches, however, could be triggered prematurely by accidentally jolting *TAVE* when it was being loaded on the spin table. If this occurred, the circuit could be de-energized through a hand hole in the *Agena* shroud. Altitude switches going on at 5000 ft. would then take over.

The command receiver, happily, worked as planned. Ample vibration and acceleration data describing the launch were telemetered to ground stations, and analysis is currently underway at Goddard. ⌘




*REAL-TIME vibration data: (left) prior to main-engine-cutoff (MECO); (right) during MECO. Ordinate is amplitude.*





# A MATERIALS LABORATORY IN SPACE

A comprehensive understanding of the reaction of materials to outer space is an important key to this country's space program. In their study of materials, scientists at Lockheed Missiles & Space Company found the problem could be most graphically depicted by showing the various environmental factors impinging on a simple cube-shaped vehicle. A cube, placed in a noon polar circular orbit, would allow unusual isolation of the effects of space on materials; make their measurement simpler and more accurate; and offer a built-in control of the results.

For example: The horizontal surface facing away from the earth would receive only direct solar insolation, while that facing the earth would get mostly earth shine and earth-reflected solar radiation. This hypothetical model lucidly illustrates the effects of such phenomena as: Solar irradiation, sputtering, micro-meteoritic erosion, solar corpuscular radiation, auroral radiation and the like.

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# Centaur, Skybolt Controls Detailed

***Skybolt's hot gas motor pumps have operated successfully on each flight to date; Centaur posed cryogenic problems***

**by John F. Judge**

DETROIT—First details of flight control aboard NASA's *Centaur* space vehicle and the Air Force's 1000-mile *Skybolt* missile were disclosed at the recent annual Vickers, Inc., Aerospace Fluid Power Conference here.

H. D. Davis, of General Dynamics/Astronautics, said the flight control system on *Centaur* presented an entirely new environmental problem: both propellants are liquified cryogenic gases. Further, he said, one of the proposed *Centaur* missions involves a restart after coasting in space; during this period, most of the accessory equipment will be non-operative and exposed to the extremely low temperatures generated by the cryogenic propellants.

Hot gas, cryogenic gas, electromechanical and hydraulic servos were investigated as possible power sources. In spite of the low-temperature problem, hydraulics were chosen because of advantages in weight, schedule, technical advancement and development cost.

Flight control system designers faced a problem exactly opposite that encountered by the engine and tankage people: the propulsion system and its associated equipment must necessarily keep within the liquid hydrogen and LOX temperature ranges while flight control components must function in the same physical area yet maintain a temperature range between −30° and 400°F—the current practical working area of hydraulic systems.

Except for the temperature problem, Davis said, system design was conventional in terms of power requirements. Each engine turbo-pump is provided with a 12,000-rpm-power take-off pad of sufficient torque output to drive the main hydraulic pump—satisfying the need for a prime mover.

Engine and airframe attach clevises are provided to allow use of conventional linear, pinned-down actuators for engine positioning. One advanced feature is the incorporation of a derivative pressure feed-back servo valve, characterized by a low pass effect which damps out high-frequency mechanical inputs to the servo loop.

• **Cryogenic dictates** — Davis said temperature considerations wielded the heaviest influence. All components used for production and regulation of hydraulic power are packaged into one compact unit mounted on the engine accessory pad. These components include:

—A miniaturized, cartridge-type fixed-displacement pump used for main-pressure generation and embedded in the power package body to keep it warm. A nylon coupling to the engine forms a thermal barrier, as does a plastic insulating block.

—A 1.35-cu.-in. (air volume) accumulator with charging gage and fitting, which acts to dampen surges in output pressure with variations in system flow rate. Installed transversally in the power package, the assembly is almost completely buried and its location prevents cooling of the gas charge.

—A bootstrap-activated fluid reservoir. The largest component in the power unit, the reservoir forms the main body. Supercharged inlet pressure for the main pump is obtained in the reservoir by applying pump outlet pressure to the smaller area of a differential area piston. The 25:1 ratio provides a nominal supercharged pressure of 40 psi in the reservoir.

—Electric motor-driven recirculating pump and allied equipment. Davis said studies indicated that the power unit constituted a thermal reservoir adequate to maintain the system temperature within operating limits if properly insulated, and heated fluid could be recirculated to the more exposed lines and actuators.

—A second cartridge-type pump, driven at 6000 rpm by a 28-volt, compound-wound, d-c motor which, in turn, is thermostatically controlled to activate when the coldest points of the system reach a pre-set temperature.

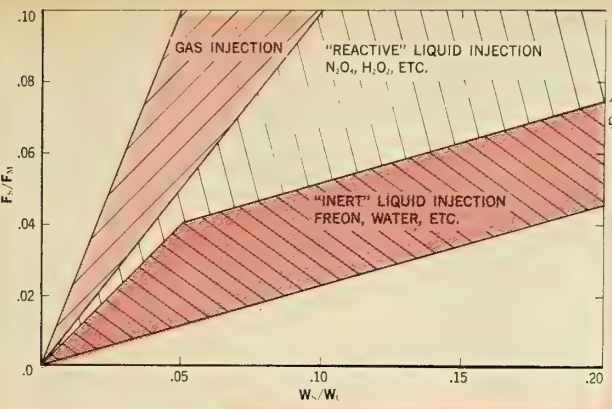
Davis said the packaging concept for the actuator and power unit assemblies probably would have been adopted, with slightly less impetus, even if environmental requirements had not so dictated. This is the general trend because of its advantages in reliability, weight savings and maintainability.

• **Flying hot gas system**—In contrast to *Centaur*, the Air Force's Douglas *Skybolt* air-launched missile uses hot-gas motor pump units in each of its two stages to supply hydraulic power to the flight controls.

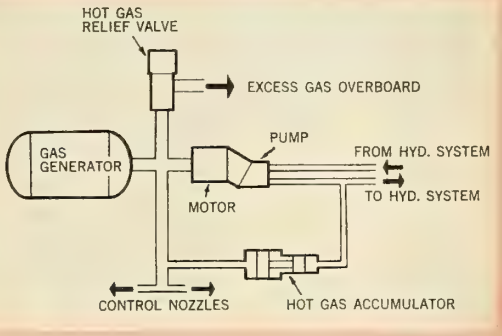
Harris Howard and Will Klock of Vickers/Torrance told the conference the system has operated successfully on every *Skybolt* flight to date.

The motor pumps in both stages are essentially identical except for power output and size. Both are integrated, fixed-displacement motors with a fixed-displacement pump.

The first-stage unit is a standard 3909-30° pump driven by a 3912-30°




*Approximate comparative results to be expected from liquid and gas injection methods.*




*Schematic shows Skybolt gas system control. System, except motor pump, was designed by Douglas Aircraft Co.*

motor. Output is 22 hp at 7800 rpm. The system pressure is 3200 psig and maximum flow is 12 gpm. The package weighs 8 lbs.

The second-stage unit is a standard 3906-size 30° pump driven by a 3907-30° motor through a common shaft. Its output is 5.6 hp at 7500 rpm. The system pressure is a nominal 3200 psig and maximum flow is 3 gpm. The weight of this unit is 3.8 lbs.

Specific fuel consumption of the first-stage motor is 11 lbs./hp-hr at an output of 15 hp. The second-stage specific fuel consumption is 17 lbs./hp-hr at an output of 5 hp. Howard and Klock add an overall efficiency loss of 8% in the pump and a factor of 25% against the theoretical propellant gas flow to compensate for variations and to provide for an operating margin.

Hot gas at 2000°F is supplied by a solid-propellant gas generator. Gas pressure is controlled by a hot-gas relief valve which maintains 2000 psig gas pressure at the motor inlet, venting the excess gas overboard. Gas for the generator is also taken off upstream of the motor to operate other subsystems such as the control nozzles.

The motor pump system is torque-balanced—with constant torque input to the motor controlled by the hot-gas relief valve, the unit adjusts its speed to meet the hydraulic system demand.

A hot-gas accumulator, using hot gas to energize the hydraulic side, supplies the peak flow demand of the system. Using hot gas for pressurization of the accumulator eliminates the need for a pre-charged accumulator.

Motor inlet and exhaust valves are copper-impregnated carbon retained by a pure molybdenum ring which provides the required resistance to internal gas pressure. The molybdenum has a temperature expansion coefficient similar to that of the valve material and also has the necesary high-temperature strength. All exposed hold-down springs are René 41 steel.

Vickers developed a nitriding process which Howard calls a substantial breakthrough in the achievement of a reliable unit. The motor cylinder block —of type 316 corrosion-resistant steel— was nitrided through this process.

The block is retained by ball bearings on its outside diameter. The nine motor pistons are free-floating and fabricated from hardened M-2 tool steel, as are the rods. Two Hastelloy C-2 piston rings with staggered gaps are used on each piston in a single groove.

The block is connected to the common shaft through a set of bevel gears. A pressure-balanced, carbon face-type seal of bellows construction to minimize elastomeric seals secures the pump case from the motor case.

A standard universal link drives the conventional pump rotating group. Thrust loads are balanced between pump and motor except for efficiency losses— the slight remaining residual thrust is absorbed by the bearing stack on the shaft.

A slight lubrication and cooling flow is introduced to the motor case during operation. This flow, says Howard, is no more than 0.15 gpm for the second-stage unit and no more than 0.25 gpm for the first stage. The latter is vented through the gas exhaust system.

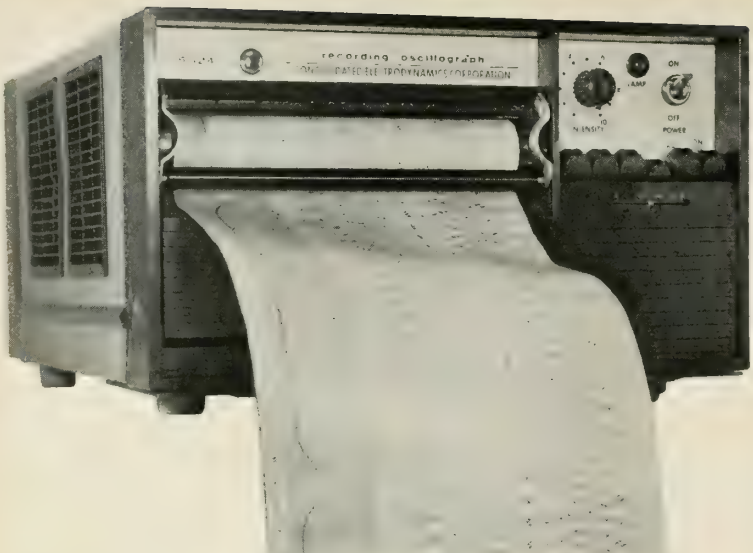
The present system provides these flow rates, but acceptance tests are run with lower rates. The amount of oil consumed in the *Skybolt* system is 3.1 lbs./min. for both stages combined. Howard and Klock indicated that feasibility of substantially lower amounts has been demonstrated.

• **Development problems**—Solutions had to be found in the areas of gas admission and exhaust, temperature and materials, and adequate cooling and lubrication within the weight, size, and operational limitations imposed.

The temperature regime ranged from in excess of 1900°F at the motor inlet to sub-zero at the same point during cold-gas checkouts. Pump and oil temperatures range over the usual military requirements of −65° to 275°F. The highest external temperature during operation is below 400°F at the motor housing.

In addition to the materials covered above, Vickers is continuing work on the Hastelloy and Satellite steel series, cermets and refractory materials, pyrolitic graphite, sapphire, H-11, Vascojet 1000 steel, 18% nickel maraging steel and Clevite 300 sintered iron. The aim is to acquire better processing and material control and arrive at longer duty cycles.

Studies in progress are directed toward the development of motors with higher operating temperatures and in propellants with lower burning temperatures. While this seems to be a contradiction, Howard and Klock say both achieve the same result—increasing the duty cycle duration.




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Other schemes, using devices to control the gas generator pressure and therefore the burning rate of the propellant, have been considered, but the Vickers experts did not discuss these in detail. Shaped-propellant grains which provide, for example, larger gas flow at the beginning of the duty cycle are practical and are used in *Skybolt*.

Thrust vector control through secondary injection methods was discussed by C. J. Green, U.S. Naval Ordnance Test Station, China Lake, Calif. Green covered the system design considerations in general and described both liquid and gas injection procedures.

Liquid secondary injection is presently being used on vehicles where the required total control impulse is less than 2% of the main propulsion system's impulse in upper-stage vehicles. The other cases cover those propulsion systems involving combustion temperatures and composition precluding the use of mechanical systems.

The fundamental difference between liquid and gas systems, Green says, is that the liquid must undergo a phase change within the nozzle. If it remains a liquid, its vectoring effect is negligible.

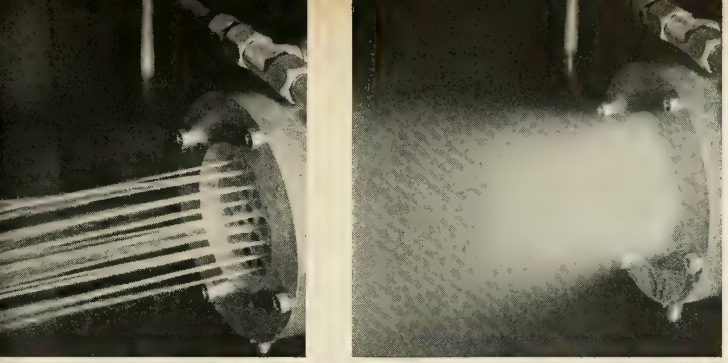
Green says gas injection systems were being investigated as early as 1952 by United Aircraft, but this, and much of the subsequent work, involved cold-gas systems. Early tests did indicate that a potentially high-performance control technique was available when the injectant total temperature approached the primary stream temperature.

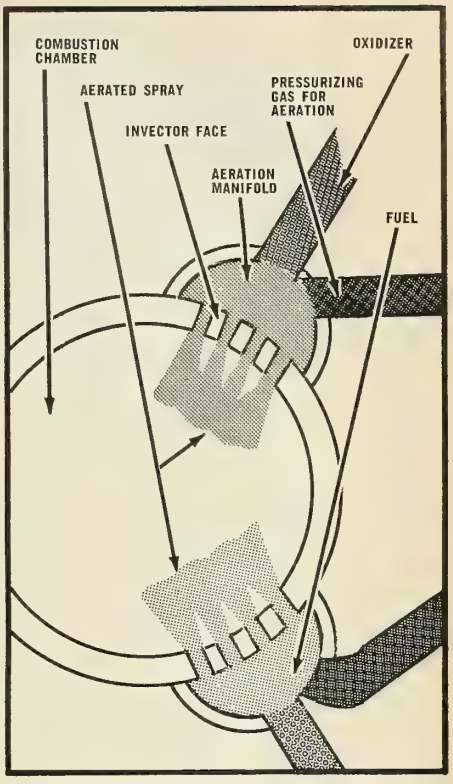
In a nutshell, a practical gas-injection system would have to use a high-temperature gas, says Green. And the high-temperature materials problem is precisely the main disadvantage of hot-gas injection and the reason why a successful system has not yet been built.

Green considers liquid injection a state-of-the-art thrust vector control technique which offers a solution to many of the problems resulting from the advent of high-performance upper-stage engines. Empirical systems have been developed which permit the calculation of system requirements and characteristics from sub-scale data.

Vickers developments in reciprocating power units were outlined by N. E. Morgan, W. D. Morath and R. C. Thomas of Vickers/Torrance. The piston engine has successfully used the $O_2$-$H_2$ combination and was described in relation to space power systems. Other fuels have been used and the engine has demonstrated versatility in operating at various speeds with these various fuels and combustion techniques.

Other papers covered hydraulic fluid contamination, reliability, new pump developments, advanced reaction control systems (M/R, Aug. 6, p. 28). ⁂






*UTC PHOTOS show (at left) conventional injection of liquid propellant into rocket engine combustion chamber, and (right) injection utilizing aeration throttling. RIGHT: Diagram of process indicates location of aeration manifolds.*

space propulsion

# UTC Claims Aeration Eliminates Instability

by Frank G. McGuire

USE OF aeration to throttle liquid propellant rocket engines to less than 2% of full thrust without combustion instability has been claimed by United Technology Corp.

The technique uses propulsion system pressurizing gas to introduce bubbles into propellant lines, creating a fine mist instead of streams in the combustion chamber.

Herbert R. Lawrence, vice president and director of UTC's engineering division, said the method hinges on a special manifold for mixing the gas and fluids in proportions dependent upon the degree of thrust reduction needed. Approximately 100 hot firings with experimental hardware have proved out the principle of the technique, and UTC is now building larger test rigs.

A prime candidate for the aeration technique is the lunar excursion module of *Apollo,* which has a thrust requirement of about 8000 lbs.—just the thrust level of UTC's new test engine for further development of the aeration method.

Company officials said the technique could also be incorporated into existing hardware, and specifically cited the *Gemini-Agena* rendevous mission as a prime example of the technique's potential benefits.

A company-funded project, the aeration system has not yet been bought by any government agency or system contractor, but UTC said it has briefed appropriate persons on the development.

The firm said combustion instability is completely eliminated when aeration is used, and the system helps greatly in preventing instability even when throttling is not desired.

At thrust levels of about 10% or less, both aeration and valving of propellant lines can be used in conjunction to advantage. The present test engine is a 300-lb.-thrust model, which has been operated at 5 lbs. thrust without combustion problems. The new 8000-lb.-thrust engine is expected to be in operation within three weeks.

Nitrogen, helium and other inert gases have been tested on such propellants as nitrogen tetroxide, hydrazine, hydrazine/UDMH, and other storables, but not yet on cryogenic propellants. The technique improves fuel economy at low thrust levels, and could be installed on current models of rocket engines at about 1% of the propulsion system cost.

• **Operation**—In the aeration method, the vehicle's pressurization system is used to perform double-duty in maintaining pressure in the propellant tanks and servicing the throttling system. About 1% more gas is needed for the added requirements, Lawrence said, and it is fed into the propellant lines through a special manifold just before the fluids enter the combustion chamber.

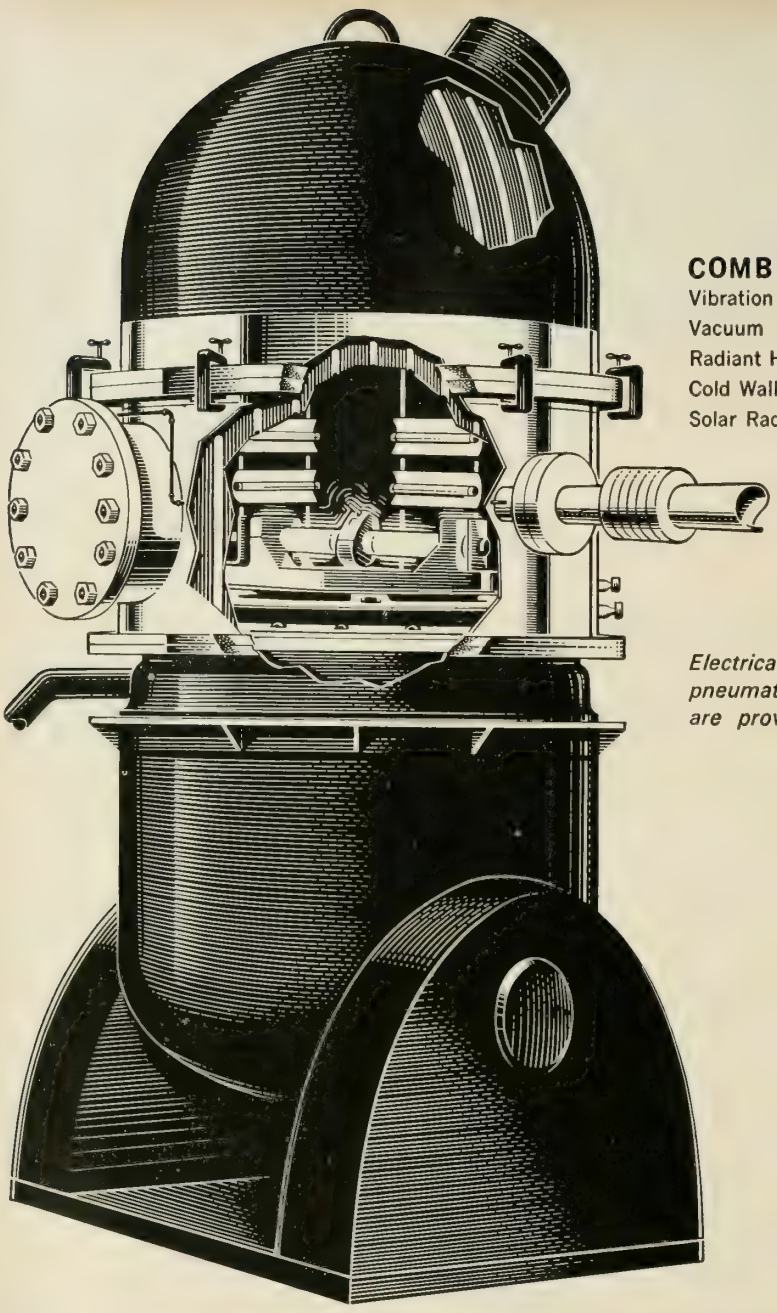
The solid stream of gas breaks up into separate bubbles in the fluid stream, (the more gas, the smaller the bubbles) and the proportion of gas to liquid, on a volume basis, is directly proportional to throttling effect.

The throttle line operates under the same pressure as the propellant tanks, and a common mechanical control system runs four valves—two on each of the propellant lines and two on the corresponding gas lines. The valves, operated from a common shaft, are geared so that opening a set of valves closes the corresponding set by the same proportion.

Lawrence stressed that a manned spacecraft could use the technique to great advantage because the pilot would have no difficulties in controlling his engine. Throttling action can be applied just as rapidly as the pilot can move the throttle handle, with no danger of explosion.

He added that the company had considered using bleed gas from one of the propellants, but decided against it because of the danger of explosions if mixture control tolerances were not precisely followed. Thus the inert gases were chosen.

Principal use for the technique is seen in orbital rendezvous missions, soft planetary landings, orbital changes, and orbital injection. ⁂



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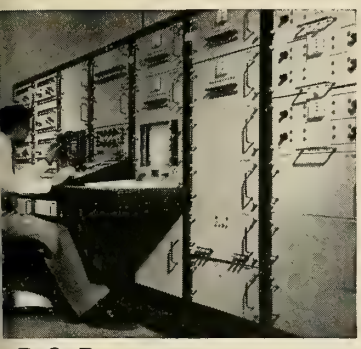
THIS SPACE SIMULATOR was designed, developed and built by the craftsmen of Beech's Aerospace Division. The experiments conducted inside this unit are one indication of Beech's space age capabilities.

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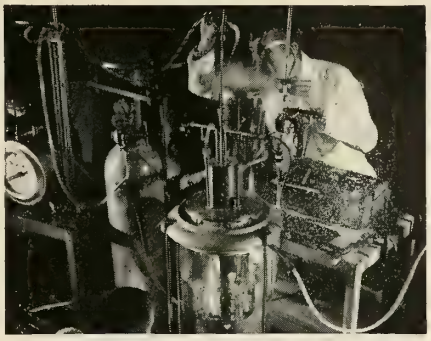
Making this possible is the unusual physical environment Beech has created at its modern aerospace center at Boulder, Colorado, and its extensive production facilities at Wichita, Kansas. Both of these facilities are staffed with expert, seasoned personnel who have long worked together on aerospace problems.

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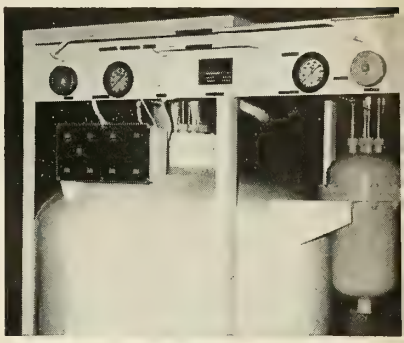
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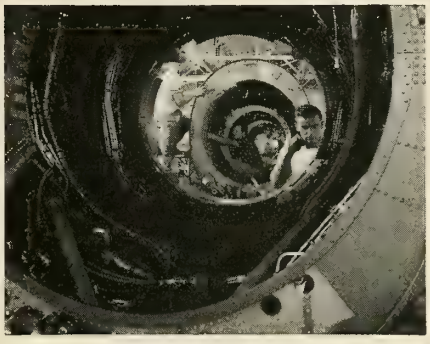
***Propulsion...***



***Auxiliary Power...***




***GSE...***



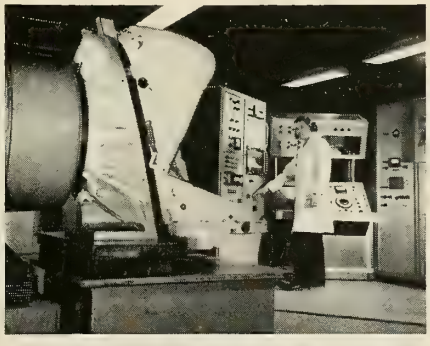
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# Long-Duration Mach 15 Shock Tunnel Shown

## *Cornell Aeronautical Laboratory installation cost $5 million, will be used in ARPA's Project Defender*

by Charles D. LaFond

BUFFALO, N.Y.—The first long-duration hypersonic shock tunnel in the United States—and quite probably the world's first—has been demonstrated successfully here.

The facility employs a rotating, multiple-shock-tube assembly to provide a continuous clean air stream at temperatures up to 9000°R and up to 200 atmospheres for periods of from 2-15 seconds. Ultimately, developers say, a Mach number range of from 6-15 will be obtainable.

In its first press showing last month, the Wave Superheater Hypersonic Tunnel, developed and built by Cornell Aeronautical Laboratory, Inc., disintegrated a 6 x 1-in.-dia. solid carbon rod. Supply temperature exceeded 6000°R at 60 atmospheres during the 3-sec. test.

The $5-million test facility is sponsored by the Advanced Research Projects Agency. Under R&D for over 3 years, the Wave Superheater is now in its final development and test stage.

When completed it will be used to support classified ARPA studies in Project Defender and will be considered a U.S. test center for use by all agencies. CAL will continue to operate the new tunnel.

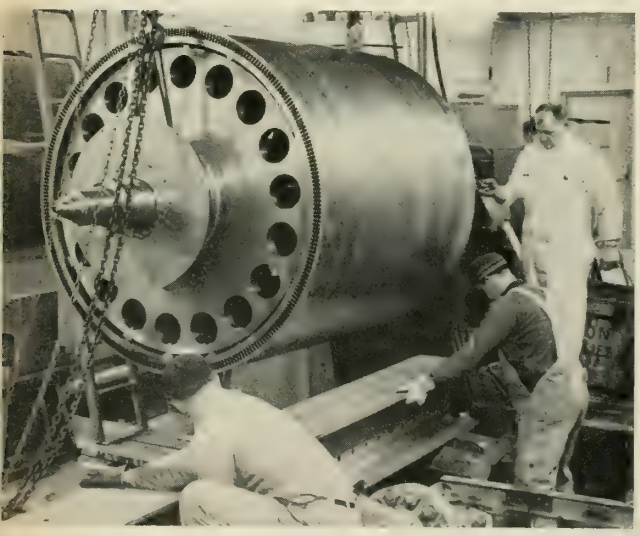
The Lab already has operational a 48-in., Mach 12-22 shock tunnel; a 6-ft., Mach 10-30 shock tunnel; a supersonic (Mach-7) shock tunnel; plus radiation (Mach-14), chemical (Mach-10), and four miscellaneous (Mach 1-7) shock tubes.

Two new facilities also now in early design will be built soon to meet upcoming space needs. One is described by CAL officials as a high-energy short-duration tunnel; the other will be a low-density shock tube capable of shock velocities to 40,000 ft./sec.

The Wave Superheater is not expected to replace conventional short-duration shock tubes or tunnels, asserted Dr. A. H. Flax, CAL vice president and technical director. But Flax said it will permit heretofore-impossible laboratory tests.

With such long duration times, instead of the more usual millisecond-range systems, new materials and structures testing may be achieved. And the new tunnel also provides an uncontaminated air stream.

Six percent or more of carbon-compound flow contamination has limited use of other existing hypersonic tunnels, Flax claimed; these, he noted, are the types used so far for re-entry ablation studies. With availability of the Wave Superheater, said Flax, a restudy of



*SIX-TON ROTOR permits continuous hot air flow in new hypersonic tunnel. Rotor is driven at speeds up to 2700 rpm.*



*MACH-15 TEST section of the Wave Superheater shown looking upstream into nozzle. Models as large as two feet in diameter may be tested for up to 15 sec. in this long-duration shock tunnel.*

many ablating materials and re-entry shapes may now be in order.

• **288-barrel gun**—Heart of CAL's hypersonic facility is a 6-ton rotor built by Twentieth Century Machine Co. of Utica, Mich. It is the largest precipitation-hardened stainless-steel forging ever made by U.S. Steel.

Built at a cost of over $350,000, it is designed to rotate at speeds up to 2700 rpm under a controlled temperature of 1160°R to minimize thermal stress.

The rotor was fabricated in three 22-in.-long sections of rings. Then, 288 oblong holes measuring 0.55-in. x 1.43 in. were drilled the length of each ring about the circumference. When assembled later, the slots were aligned to an accuracy of less than 0.002 in., according to CAL. Drilling and broaching alone required one year's time.

Each of the 288 slots serves as a shock tube that is fired once each revolution. Thus, when the rotor is driven at a high angular speed, the net effect is that of a large steady-flow shock tube operated much like a Gatling gun for hot air generation.

As the huge rotor revolves, each tube passes fixed gas-supply nozzles at each end of the drum. When the nozzles are passed at a high translational velocity, the result functionally is that of a quick-opening valve analogous to the conventional diaphragm rupture in normal shock tubes.

• **Complex plumbing**—A vast amount of auxiliary equipment is required to complete the flow requirements in the open-loop system and to direct and process the various gas streams.

Each terminates at the specially designed nozzles at the ends of the rotor. The overall system is a blow-down type, in effect consisting of four blow-down devices operating simultaneously.

Six nozzles at the rotor ends supply or collect the gases (five are at the collector end, from which the superheated air flows):

1) The charge nozzle delivers air to be superheated.

2) The collector nozzle collects processed air.

3) The reclamation nozzle receives a combination of the driver helium and charge air.

4) The coolant and (5) prime nozzles deliver gases to the rotor.

6) The driver gas nozzle is at the upstream end of the rotor.

When filled with charge air, each shock tube passes the driver gas nozzle, which admits a slug of high-pressure helium. The resulting shock wave compresses, superheats, and accelerates air toward the collector end of the tube, where it is collected and added to the discharge of adjoining tubes. Each tube faces the collector nozzle just long enough to discharge its processed air; rotation continues to a position in front of the reclamation nozzle.

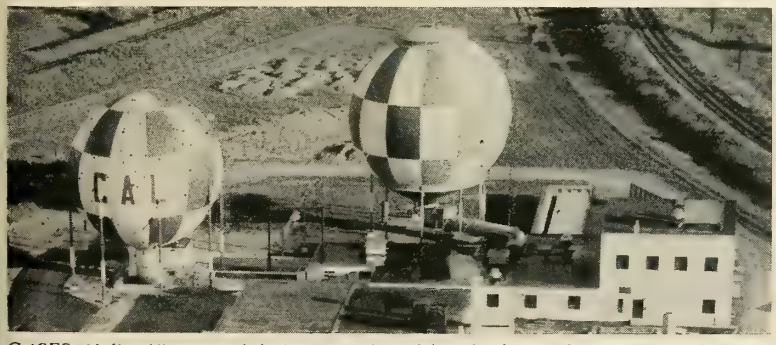
The latter receives the spent driver gas adjacent to the driver-driven gas interface, which also is at a relatively high pressure and temperature. When the pressure of the spent driver gas still in a tube decreases to about 1 atms., it moves past the reclamation nozzle.

The tube rotation continues, passing it in front of the nozzle supplying coolant helium and thus reversing the flow. The tube is then exposed to a nozzle which supplies prime gas (helium) at roughly rotor temperature (700°F). This establishes a uniform flow through the tube, affording minimum impedance to the charge air introduced during the next cycle. Each complete cycle requires about 22 milliseconds.

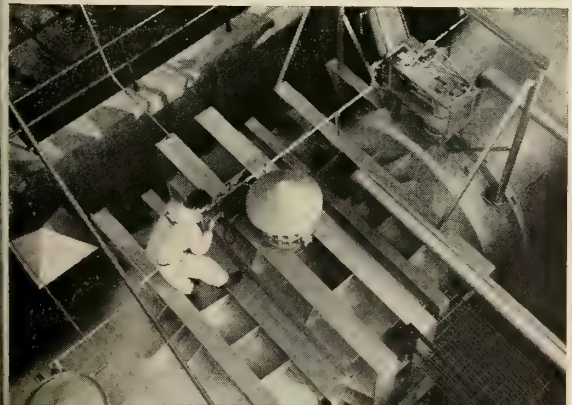
The helium driver gas, stored at 2000 psi, is regulated by a throttle valve that controls the pressure at which the helium enters two 100-ton pebble ($Al_2O_3$) furnaces. Control is determined by the shock strength required within the superheater tubes. In the furnaces, the helium is preheated to 2160°R, and from there it flows to the driver nozzle.

• **Mach 15 by December**—At the present time, CAL's Mach-6 tunnel has been calibrated. It is an atmospheric-discharge type employing an 8-in.-dia.-exit conical nozzle. The tunnel has a model injection system and a 20-in.-square test section.

The Mach-15 tunnel recently in-



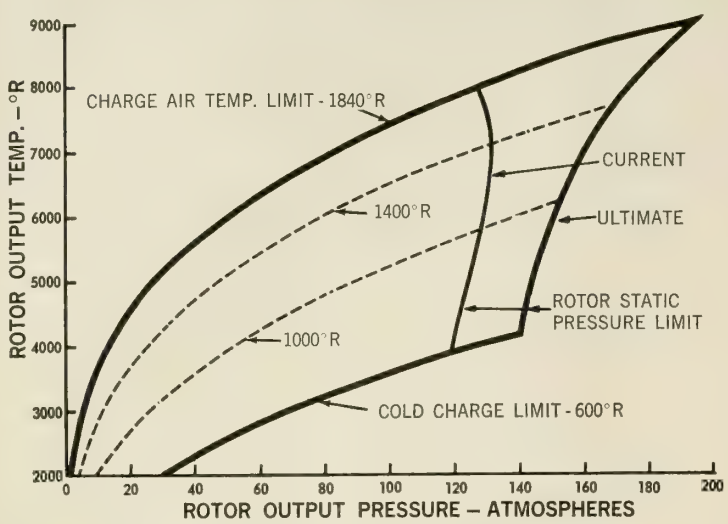

*GASES AND AIR required during operation of big shock tunnel terminate in these two reservoirs. Tank at left is 125,000-cu.-ft. vacuum container; one at right is 150,000-cu.-ft. diaphragm pressure vessel for helium reclamation.*



*10-TON COOLER can absorb up to 16 thermal megawatts of heat. It has 888 copper tubes, measures 12 x 14 x 4 ft.*



*TWO 100-TON pebble heaters preheat helium driver gas before release into rotor shock tubes. Each takes 20 lbs. per sec.*




*TYPICAL PERFORMANCE graph of the CAL hypersonic tunnel.*

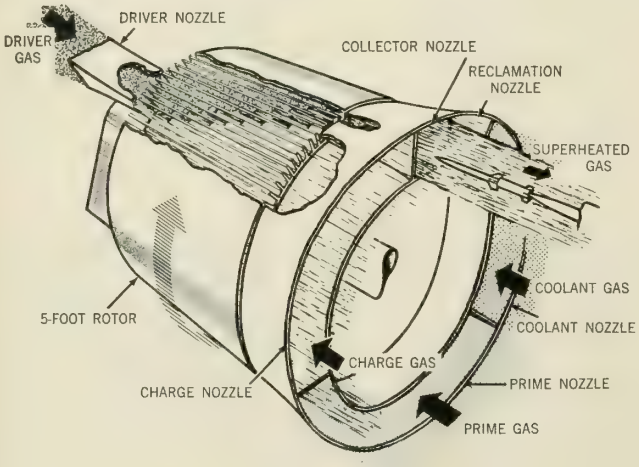
stalled uses a large vacuum sphere for discharge. The 9½-ft.-dia. nozzle exit assures a test section capable of handilng models up to 2 ft. in diameter. The test section measures 20 ft. in diameter, with a 6-ft.-dia. flow core.

Test runs are limited to 15 sec. by storage and heat capacity of the driver and charger gases and by the receiver vacuum capacity. Four hours are required to recharge after a full period test and less for shorter runs. The first Mach-15 test run will be made early in December, CAL officials assert.

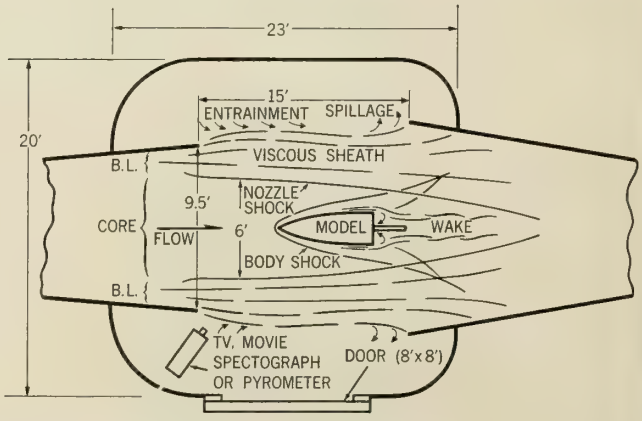
Spent process gases are recovered in a 150,000-cu.-ft. diaphragm storage tank. Collected air passing through the tunnel is accumulated in a 125,000-cu.-ft. vacuum tank.

Helium is reclaimed after each test run with a loss of less than 5%.

A 10-ton cooler employed in the operation can absorb up to 21,000 horsepower (or 16 thermal megawatts). Measuring 12 x 14 x 4 ft., the cooler holds 888 copper tubes for heat dissipation. ■




*WAVE SUPERHEATER hypersonic tunnel rotor and nozzles.*




*HYPERSONIC flow in the CAL tunnel is shown with a typical model and its related flow pattern.*

# Aeronutronic Expanding Production

## *Shillelagh cost reduction program put division in black; missile and other programs nearing production*

**by Willard E. Wilks**

NEWPORT BEACH, CALIF. — An Army-ordered cutback in costs of the *Shillelagh* missile program has brought about a dramatic improvement in the fiscal position of the Aeronutronic Division of Ford Motor Co. The division is now gearing itself for a major expansion from research into production.

*Shillelagh* itself is in the advanced production engineering phase. Aeronutronic, which has agreed to provide fabrication facilities for the surface-to-surface tactical weapon, now must decide whether to locate fabrication at an existing Ford plant or a new plant in the East.

Where the *Shillelagh* will be built depends to a large extent upon the 1963 public demand on Ford's automotive facilities, says Aeronutronic General Manager John B. Lawson. Another factor affecting location is availability of government loading plants.

"We don't want big production here (at Newport Beach)," Lawson said, "since research and production don't mix."

Last month the division announced the opening at nearby Santa Ana of a 16,000-sq.-ft. off-site production facility which will handle a re-entry hardware program and other smaller projects. Lawson said plans call for growing out of that faciilty in five years.

• **Bright outlook**—Aeronutronic has "recently moved into the black," Lawson reported. He declined to say that this means "well" into the black, but he declared that "the outlook is very encouraging."

Lawson, a 13-year Ford veteran who took charge of the division last May, scored as "ridiculous" rumors that Aeronutronic would be sold or merged with Ford's Philco division. He said he had recently reassured defense officials in Washington that "there are no plans to dispose of the company. I also told them that when we acquired Philco we reviewed the merger idea, but decided overlapping of interests was just fringe, and the divisions would remain independent."

Since last November, when the Army ordered *Shillelagh* costs brought into line, Aeronutronic has cut its work force from a peak of 3200 to 2400—less than half the 5000-man staff which had been planned for the $33-million 200-acre Newport Beach site by the end of this year.

The *Shillelagh* cut held down sales growth—"without it, we would have had another 20% in sales now," Lawson noted—but there was no drop otherwise.

Fifty experienced production personnel from other Ford divisions have come to Aeronutronic in recent months to prepare for a "major" expansion into production. Lawson's own forte with Ford has been bringing projects from late development into production.

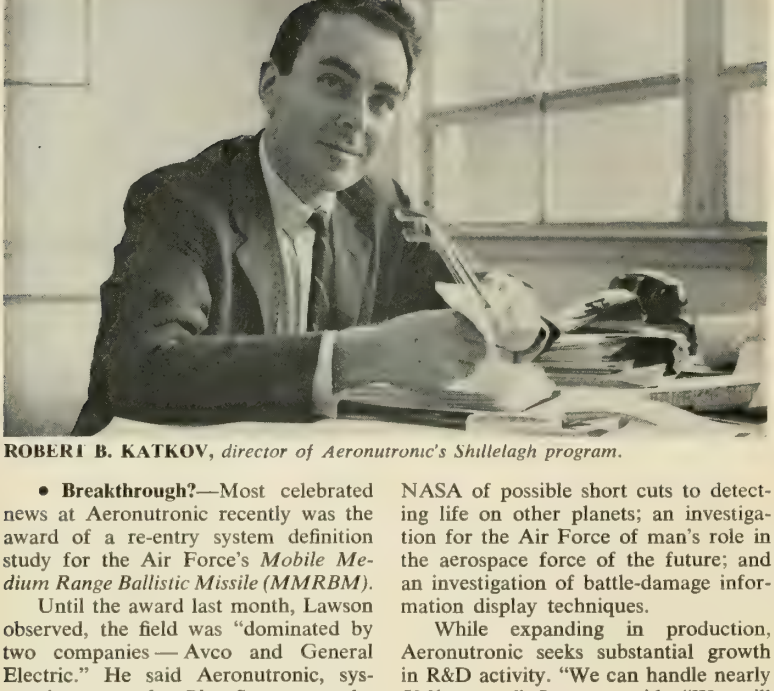
"Until now most activity has been research," Lawson said. "Now we are beginning to move into production in several programs."

Programs or products going into or approaching production include *Shillelagh*—with $42 million received to date, the biggest of the 58 contracts now in force; a classified Air Force re-entry decoy program; the Army Tactical Operations Center (ARTOC), recently fully funded to $19 million and reaching acceptance test stage; and BIAX computer memory units.

At present, the BIAX units are the biggest production item: Dr. Donal B. Duncan, assistant general manager, says the sale of more than 50 has exceeded Aeronutronic's expectations by 150%.



**JOHN B. LAWSON** *(left), general manager, and* **DR. DONAL B. DUNCAN,** *assistant general manager-operations, discuss future plans at headquarters of Aeronutronic.*



**ROBERT B. KATKOV,** *director of Aeronutronic's Shillelagh program.*

• **Breakthrough?**—Most celebrated news at Aeronutronic recently was the award of a re-entry system definition study for the Air Force's *Mobile Medium Range Ballistic Missile (MMRBM).*

Until the award last month, Lawson observed, the field was "dominated by two companies — Avco and General Electric." He said Aeronutronic, system integrator for *Blue Scout,* sees the contract as a breakthrough into a promising new market area: "The Air Force is not going to buy more missiles, but will improve re-entry systems. We expect a lot of re-entry business in the next five years."

The division also expects more *Ranger* work in the follow-on program announced by NASA. It has devised ways to obtain more lunar surface data for *Apollo* by using the basic capsule it developed (for about $10 million) for the second *Ranger* series.

In its future space effort, Aeronutronic will concentrate on strictly unmanned aspects, says Dr. Robert S. Carlson, space and weapon system director. "We gradually decided it wasn't realistic for us to compete in the prime manned program," Carlson explained. "But we are looking into anything that ties into the manned program."

• **R&D buildup**—In another area, Carlson's group has important contracts in tracking network and range systems.

Bidding prime with Philco, it has proposals for a real-time computation system for Atlantic Missile Range and a ground environment system for *Gemini* and *Apollo.*

"We see a lot of potential," Carlson said, "in tying together all of the division's capabilities for the space program—re-entry, decoys, controls and displays, advanced computer techniques, photographic techniques, communications, range system analysis, electronics, optics and propulsion research."

R&D contracts include a study for NASA of possible short cuts to detecting life on other planets; an investigation for the Air Force of man's role in the aerospace force of the future; and an investigation of battle-damage information display techniques.

While expanding in production, Aeronutronic seeks substantial growth in R&D activity. "We can handle nearly 50% more," Lawson said. "We will build up to capacity."

Duncan said Aeronutronic research effort is directed by two considerations: A firm period of funding, such as a year, and a "discretionary, relatively large amount of funds" for exploratory research.

"We have a highly directed research program for something like two-thirds of our effort. For the rest, we believe in giving the research people their head to investigate things that appear to them to have some promise. BIAX is an example of this." Development of the tiny BIAX ferrite computer elements, some 20,000 of which go into a single memory unit, has given the division its only product in the commercial area.

• **In the works**—Division research effort includes a great deal of emphasis on materials for re-entry vehicles. These include work with the AUSFORM high-strength steel process developed by the Ford Scientific Laboratory. Aeronutronic research laboratory has done considerable work in correlating the AUSFORM steel in relation to thermal, structural and mechanical properties of chemical and mechanical history. "We are preparing a product development with it," Duncan said, adding that the material is being supplied to solid motor-case manufacturers.

In-house space program research includes extensive investigation aimed at determining how unmanned vehicles can obtain significant information from the Moon and planets. Extending the *Ranger* approach, the division believes there are many possibilities for semi-hard capsule type landings, researchers having found that "there is little that cannot be hard-landed, except organisms, solid rockets, and perhaps vidicon tubes."

One possibility the division may offer NASA for the *Apollo* program is a capsule that would be released from *Apollo* while in lunar orbit to descend and obtain landing information before descent of the LEM vehicle. This is included in in-house investigation of various lunar-landing aids which would provide last-minute pre-touchdown information for *Apollo*-type missions, such as surface hardness. Proposals have been made to LEM competitors.

A proposal for *Ranger* follow-on is a photographic system that would obtain pictures of the lunar surface following *Ranger's* landing. The system would employ an extremely slow scanning technique and a high-speed development process originally devised for the ARTOC display system, furnishing a print in a matter of seconds. Duncan thinks the ARTOC display system has significant possibilities in other areas.

In communications technology, Aeronutronic is developing under Air Force sponsorship the PACM (Pulse Amplitude Code Modulation) telemetry system, which is able to handle data of a variety of large and small missiles and provides a standardized method of sending and receiving missile and satellite data in either analog or digital form, or both.

• **Changes made**—Since taking over at Aeronutronic, Lawson has scrapped the division's old organization in line operations groups consisting of Electronic Systems, Computer Products, Research, Weapon Systems, Automotive Electronics and Space Systems.

In a move to further centralize support and service functions while retaining the necessary individual program visibility and control, the major subdivisions have been organized into five major technical programs—*Shillelagh,* Re-entry Systems, Electronics, Space and Weapon Systems, and Research Laboratory.

Until the reorganization, the operations groups had all of their own marketing, finance and personnel functions. These were centralized in a division staff, with contract administration and program control functions remaining within the program organizations. At the same time, in most cases, reliability, product qualification, fabrication, assembly, checkout, product planning, purchasing, facilities and services were lumped in an operations support staff. Division size, current commitments and planned new business were major considerations determining the new organizational approach, Lawson said. ‡

## GD Profits This Year

General Dynamics Corp., which in 1961 showed the greatest known losses of any company in history, is running in the black in 1962. More than $11 million in the third quarter brought total net earnings to almost $34 million for the first nine months of this year.

The company's earnings this year are not subject to Federal income taxes, because of a tax credit resulting from last year's losses, which amounted to $56,915,183 in the first three quarters of 1961.

## Industry Facilities

Orlando Div. of Martin Co. has consolidated all its thin-film design, production and testing operations at a single 3500-sq.-ft. facility—as a department of Martin-Orlando's Advanced Technology Group. Only related effort that will remain outside the new complex is research into active thin-film devices including triode amplifiers. Goals of the new setup are increased reliability and lower production costs for thin films. . . . *Brown Engineering Co., Inc., Huntsville, Ala., has completed the first phase of its new facilities construction program at Huntsville Research Park. Brown's president, Milton Cummings, says the new facility "has substantially increased our engineering and manufacturing support capabliity to the missile and space field."* . . . Armco Steel Corp., a major U. S. producer of stainless steel bar and wire, will build a new 2000-ton, high-speed forging press installation at its Baltimore Works. The new press—reportedly among the largest devoted exclusively to forging stainless steel—will handle ingots up to 36 in. in diameter. . . . *Aircraft Armaments, Inc., Cockeysville, Md., will open a Pacific division in the western San Fernando Valley by the first of the year. AAI-Pacific will have a 15,000-sq.-ft. facility for defense engineering and manufacturing, but arrangements for the exact site have not been completed.* . . . In a move to boost productive capacity by 50%, Kollmorgen Corp.'s Inland Motor Corp. of Va. has opened a new 10,000-sq.-ft. addition to its Radford, Va., plant. Inland Motor makes compact precision d-c torque motors, rotary amplifiers and tachometer generators. . . . *Elco Corp. of Philadelphia, manufacturer of electronic connectors, has opened a new 52,000-sq.-ft. plant at Huntingdon, Pa. The $350,000 plant will house Huntingdon Scientifics, Inc., and Oak Engineering Co., Inc., two Elco subsidiaries.* . . . Phelps Dodge Electronics Products Corp.—recently formed to provide R&D and applied engineering in systems communications —now has engineering and production facilities at North Haven, Conn. Fabrication, testing and engineering functions occupy 51,500 sq. ft. at the new facility. . . . *United Technology Corp., subsidiary of United Aircraft Corp., has set up a new technical liaison office in Houston. George Alexander will head the new office.*

## Automatic Checkout Parley Planned

A special workshop on programing languages for automatic checkout is being planned by the Computer Programing Subcommittee, Computing Devices Committee, American Institute of Electrical Engineers. Those interested in attending such a workshop should send name, address and brief resume to Burton Went, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio.

## Organizational Changes

Dresser Industries, Dallas, has formed a new division, Dresser Vacuum, at the New England Industrial Center, Needham Heights, Mass. Dresser Vacuum will develop and manufacture pumping units, components and complete systems for vacuum technique applications. . . . *Four activities at United Technology Corp. have been consolidated in a single planning and marketing staff. Existing marketing, contract management, corporate planning and product development organizations will make up the new staff, reporting directly to Director Melvin Cohen.* . . . In a move reflecting increasing efforts to offer a "complete space systems package" and to strengthen its marketing activities, Philco Corp.'s Western Development Laboratories has established a Spacecraft Systems Marketing Dept. and a Space Systems Support Marketing Dept. Also, field sales offices have been set up at Washington, Cape Canaveral, Houston, and Los Angeles to implement the WDL customer development program. . . . *Radio Corp. of America's Defense Electronic Products Organization (DEP) has: combined its Major Systems Div. (MSD) and its Missile Surface and Radar Div. (MS&RD), both of which are at Moorestown, N.J.; and set up a Systems Engineering Evaluation and Research Organization (SEER)—formerly the systems engineering group within MSD. MSD was originally established to manage the Ballistic Missile Early Warning System project, now nearing completion. Purpose of the shift is to make available to all DEP divisions MSD's systems capability.*

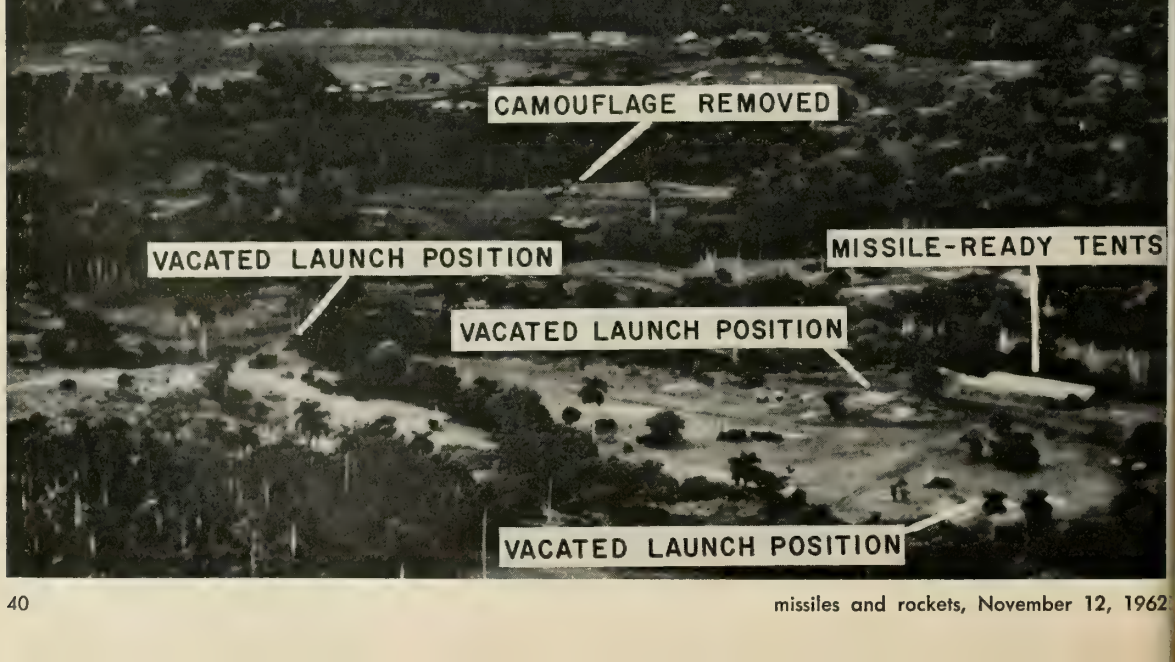
## Signed, Sold, Delivered

Gladding, McBean & Co., Los Angeles, and Lock Joint Pipe Co., East Orange, N.J., have merged to form International Pipe & Ceramics Corp. The new firm's ceramics division—which retains the Gladding, McBean name—will build a $750,000 research center to develop ceramics applications for both commercial and military markets. . . . *Holly Corp., Azusa, Calif., has sold assets of its wholly owned, Santa Ana, Calif., subsidiary, Standard Rectifier Corp., to American Micro Devices, Inc., Pheonix, Ariz.* . . . Giannini Controls Corp., Durante, Calif., has acquired Powertron Ultrasonics Corp., Plainview, N.Y. Exchange of stock is involved in the transaction.




# Evidence of Russian Missile Pull-Out

*SOVIET DISMANTLING of medium-range ballistic missile sites in Cuba is graphically shown in these aerial photos of a site near San Cristobal. Above, the site is rapidly approaching operational status. Below, just a few days later, the site is virtually abandoned.*



# AWARDS

## AIR FORCE

$21,650,000—**General Dynamics Corp.,** San Diego, Calif., for continued work on *Atlas* missiles.

$20,000,000 — **North American Aviation, Inc.,** Downey, Calif., for production of guidance and control systems for *Minuteman* missiles.

$8,163,000—**Hughes Aircraft Co.,** Culver City, Calif., for production of missile test equipment.

$5,400,000—**Hycon Manufacturing Co.,** Los Angeles, for missile test equipment and aerial reconnaissance systems (joint venture with Navy).

$3,775,000—**Collins Radio Co.,** Dallas, for design and fabrication of two communications systems for the Atlantic Missile Range.

$3,100,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for work on space programs (2 contracts).

$2,000,000—**Radio Corp. of America,** New York, for work on Air Force space programs. Work to be done at Burlington, Mass.

$2,000,000—**Space Technology Laboratories, Inc.,** Redondo Beach, Calif., for work on space programs.

$1,775,691—**General Electric Co.,** Philadelphia, for design and development of a target for *Nike-Zeus* anti-missile missiles.

$1,513,377—**Loral Electronics Corp.,** New York, for electronic spare parts.

$1,000,000—**Marquardt Corp.,** Van Nuys, Calif., for expansion of the Air Force-Marquardt Jet Laboratory at Little Mountain, Utah.

$435,000—**Northrop Corp.'s Norair Div.,** Hawthorne, Calif., for exploration of the use of exotic columbium and molybdenum metals for aerospace vehicles.

$250,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for a study of correlation guidance system techniques.

**Fairchild Stratos Corp.,** New York, for work on the *AN-US-5* target drone (undisclosed amount).

## ARMY

$100,000,000—**Ling Temco Vought, Inc.,** Santa Monica, Calif., for development and production of *Missile B*.

$4,500,000—**Control Data Corp.,** Minneapolis, Minn., for classified electronic equipment.

$4,413,839—**Thiokol Chemical Corp.,** Bristol, Pa., for *Nike-Hercules* sustainer motors. Work to be done at Marshall, Tex.

$1,170,792—**Western Electric Co., Inc.,** New York, for electronic training devices.

$100,000—**Sylvania Electronic Systems,** Mountain View, Calif., for design, production and installation of an electronic security system for the *Nike-Hercules* missile program.

**Bendix Corp.'s Bendix-Pacific Div.,** North Hollywood, Calif., for a feasibility study of the guidance unit for the *Derringer* weapon system (undisclosed amount).

## NAVY

$132,800,000—**General Dynamics Corp.'s Electric Boat Div.,** Groton, Conn., for two additional *Polaris* missile submarines.

$92,880,000—**Newport News Shipbuilding and Drydock Co.,** Newport News, Va., for an additional *Polaris* missile submarine.

$7,500,000—**Sperry Gyroscope Co.'s Marine Div.,** Syosset, New York, for management and integration of inertial navigation subsystems for fleet ballistic missile submarines.

$5,881,478—**Philco Corp.,** Philadelphia, Pa., for guidance control sections for *Sidewinder* missiles.

$5,400,000—**Hycon Manufacturing Co.,** Los Angeles, Calif., for missile test equipment and aerial reconnaissance systems (joint venture with Air Force).

$2,800,000—**Vitro Corp., of America's Vitro Laboratories Div.,** Silver Spring, Md., for engineering services and work on the *Terrier, Tartar* and *Talos* missile systems.

$2,500,000—**Thiokol Chemical Corp.,** Bristol, Pa., for liquid propellant rocket engines.

$242,000—**Operations Research, Inc.'s Management Systems Div.,** Silver Spring, Md., for further implementation of the reliability maturing index system throughout the *Polaris* program and for further sophistication of the system.

## NASA

$19,000,000—**Pratt & Whitney's Florida Development Center,** West Palm Beach, for advanced work on the RL-10 liquid hydrogen engine designed for upper stage use with the *Centaur* and *Saturn* launch vehicles.

$7,376,379—**Electro Mechanical Research Corp.,** Sarasota, Fla., for systems to receive instrumentation measurements sent to the ground from a docking spacecraft and launch vehicle.

$3,500,000—**Sylvania Electric Products,** Waltham, Mass., for development of optical and electronic equipment in the *Orbital Astronomical Observatory*.

$1,950,000—**Radiation, Inc.,** Melbourne, Fla., for digital command encoders that will enable each station to transmit information and commands to the spacecraft.

$1,725,000—**Collins Radio Corp.,** Dallas, for command systems that will perform a function similar to that of the digital command encoders—sending information and commands to a docking spacecraft.

$1,163,700—**Quiller Construction Co.,** Los Angeles, for building additions to the Flight Research Center, Edwards, Calif.

$1,045,000—**Canoga Electronics Corp.,** Van Nuys, Calif., for tracking antenna acquisition aid systems.

$660,000—**Vitro Corp. of America's Vitro Services Div.,** Fort Walton Beach, Fla., for providing support services at the Marshall Space Flight Center's *Saturn* test facility.

$68,221—**Tulane University,** New Orleans, for a study of the causes of high-energy, low-frequency sound waves emitted during rocket tests.

$45,107—**Raytheon Co.,** Burlington, Mass., for operation and maintenance of a large horn to be used to simulate the low rumbling sound of rocket firings.

**Dresser Electronics, SIE Div.,** Houston, for the design and fabrication of a spacecraft hatch cover (undisclosed amount).

**Vickers Inc.,** Detroit, Mich., for development and testing of a solid-fuel-rocket attitude control system.

## INDUSTRY

$600,000—**Radiation, Inc.,** Melbourne, Fla., from **Bell Telephone Laboratories,** for data handling equipment for the *Nike-Hercules* system.

$400,000—**Menasco Manufacturing Co.,** Burbank, Calif., from **Westinghouse Corp.,** for *Polaris* launching system liquid spring shock absorbers.

$350,000—**Mandrel Industries, Inc.'s Meg Products Div.,** Seattle, Wash., from **Boeing Co.,** for umbilical cable assemblies for the *Minuteman* missile.

**D. B. Milliken Co.,** Arcadia, Calif., from **Space-General Corp.,** for DBM 3A 16mm motion picture cameras to record the deployment and re-entry orientation of NASA's *Inflatable Micrometeorite Paraglider* (IMP) (undisclosed amount).

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Services and materials necessary for the modification, design, adaptation and furnishing of certain accessories for two government owned wide BC-4 ballistic cameras in accordance with NASA Specification L-2496-A. Proposals are requested on a negotiated fixed price basis and proposals will be evaluated on the basis of factors stated in the RFP L-2496-A. RFP due date 11-19-62.

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Ogden Air Material Area
Hill Air Force Base, Utah
Attn: Directorate of Procurement and Production

Rocket retarding Atlantic Research P/N D20550 or Rocket Power P/N D2547-11 or General Dynamics P/N 27-04300-1 FSN 1340-703-0650 with ammunition data law MIL-L-9931, 124 each. Delivery to Hill Air Force Base. RFP No. 42-600-63-1194-Q. Approximate due date 11-22-62. Adequate drawings and specifications are not available and will not be furnished. Requests for proposals have been issued to the following firms: Atlantic Research Corp., Alexandria, Va.; General Dynamics/Astronautics, P. O. Box 569, San Diego, Calif.; Rocket Power, Inc., P. O. Box 231, Mesa, Ariz. For further information contact L. D. Wilson/OOPAM, Hill Air Force Base, Utah. It is suggested that small business firms or others interested in subcontracting opportunities in connection with these procurements make direct contact with the above firms.

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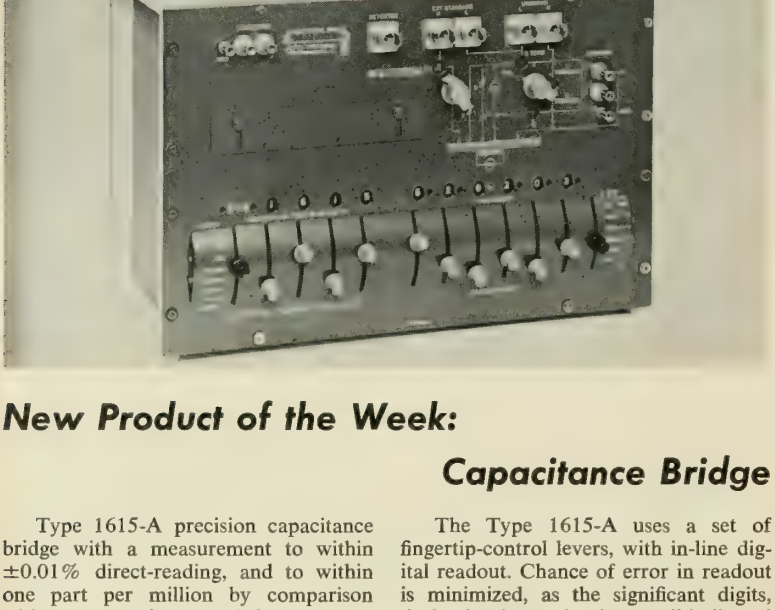
General Support Div.
Directorate of Procurement and Production
U. S. Army Missile Command
Redstone Arsenal, Ala.

The U. S. Army Missile Command proposes to procure from the Northrop Corp., Ventura, Div., repair parts in support of the *RP-76* target missile system. This synopsis is to publicize possible subcontracting opportunities and all inquiries relative to subcontracting must be referred to Northrop Corp., Ventura Div., Ventura, Calif.

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Mauler Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

*Mauler* weapon system familiarization courses and new equipment training, five courses of instructions. Deliveries required through July 1963. Deliveries to General Dynamics/Pomona, Pomona, Calif. No available drawings or specs available to support competitive procurement and lack of *Mauler* weapon equipment essential to support the courses preclude award to any other than the prime contractor General Dynamics/Pomona. All inquiries relative to subcontracting should be referred to General Dynamics/Pomona, a division of General Dynamics Corp., Pomona, Calif.



## New Product of the Week:

## Capacitance Bridge

Type 1615-A precision capacitance bridge with a measurement to within ±0.01% direct-reading, and to within one part per million by comparison with an external standard, has been developed by General Radio Co.

The bridge offers six-figure resolution, with an overall capacitance range of $10^{-17}$ to $10^{-6}$ farad. Dissipation factor range is 0.000001 to 1 at 1 kc, direct-reading. Frequency range is approximately 50 cps to 10 kc.

The Type 1615-A uses a set of fingertip-control levers, with in-line digital readout. Chance of error in readout is minimized, as the significant digits, decimal point, and units are all indicated automatically.

Two-terminal and three-terminal capacitors can be measured, the latter even in the presence of large capacitances to ground. Thus the bridge is useful for in-place measurements of circuit capacitances.

Circle No. 225 on Subscriber Service Card

### Controlled Oscillator

The Model V-510 Voltage Controlled Oscillator (VCO) has been developed by Solid State Electronics Co. for accurate conversion or carrying analog dc voltage to a linearly proportional sine wave frequency. This completely encapsulated plug-in unit's all-solid-state design insures high resistance to shock, vibration, temperature and aging effects. Standard units are calibrated for operation over a frequency range extending from 400 CPS to 70 KCPS within IRIG bands 1 to 18 (±7.5% frequency deviation) and A to E (±15% frequency deviation).

Circle No. 226 on Subscriber Service Card

### Environmental Chamber

A combination low- and high-temperature environmental chamber with a range from −125°F to 600°F is available from Webber Mfg. Co.

Model WT-12-125+600, automatically cycles from high to low temperatures in 55 minutes, and reverses these extremes in the same length of time. Accuracy is ±1°F throughout the entire range. Both heating and cooling cycles are equipped with adjustable (0 to 100%) input controllers and includes programed instrumentation.

Other features include a heat exchanger, a cascade refrigeration system with thermal capacity of 3500 BTU per hour at −125°F.

Circle No. 227 on Subscriber Service Card

### Spectrum Data Processor

A spectrum resolver integrator (Model 522) which requires no tape to resolve information is available from Technical Measurement Corp. The 522 was developed to operate as a compatible resolver with all 400 series TMC pulse height analyzers. Information stored in any desired quarter or half of the analyzer memory can be instantly subtracted from—or added to—information stored in either an adjacent quarter or on the unselected half. By accumulating or reading in reference spectra, the individual components of a complex spectrum may be removed providing concentration opportunity within the range selected. With instant, one-step reading, the 522 reports the algebraic sum of subtraction or addition operations performed in 100%, 1% or 0.1% increments. Integration is possible within any selected band of channels from 0 to 399 in one operation.

Circle No. 228 on Subscriber Service Card

### Cricket Switch

A model of subminiature, snap action Cricket Switch that combines low plunger differential with low operating force requirements has been developed for highly sensitive, narrow-tolerance applications by Fansteel Metallurgical Corp.

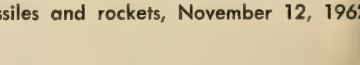
The switch has a maximum of 0.0005-in. differential between snap-open and snap-close and requires only two ounces or less operating force. It could be used with relays having low engaging force, for gauges, and control systems for missiles.

Circle No. 229 on Subscriber Service Card

### Photoelectric Tape Reader

A photoelectric tape reader for applications such as preflight test and checkout, computer loading and verification, industrial process control, data transmission and date-conversion systems is available from Minneapolis-Honeywell.

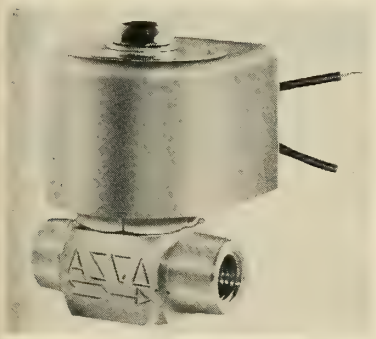
The Model 7109, available in 8- or 6-channel configuration, is bi-directional, with a 28-volt dc control signal to reserve tape motion. The unit can be stopped on a single character by external command. It has solid-state circuitry and a simplified tape drive system to reduce the number of moving parts. The reader operates at temperature extremes ranging from −40°F to 160°F. It stands vibration up to 5 G's at 5 to 500 cps, and 15-G shock of 11-milliseconds duration. It is immune to humidity, sand, dust and explosions.



Circle No. 230 on Subscriber Service Card

## Solenoid Valves

Solenoid valves for cryogenic liquids and gases from −100°F to temperatures approaching absolute zero are available from Automatic Switch Co. These 2-way valves with Teflon disc and gaskets are packless. They handle ¼-in. and ⅛-in. pipe sizes, and can be



mounted in any position. Available with brass or stainless steel body, the valves are normally closed and for a-c voltage operation.

Circle No. 231 on Subscriber Service Card

## Sampling Multiplexer

Towson Laboratories, Inc., offers a Caplexer, capacitive sampling multiplexer. A single plug-in board accommodates four channels of analog information with external programing. Any number of channels can be handled by appropriate assemblies of plug-in boards.

Analog inputs in the range of 0 to ±10 volts can be sampled with effective sampling apertures of 0.25 microsecond or less at rates as high as 200,000 per sec. Sampling errors of less than 0.5 millivolt are available. Single ended or balanced inputs can be provided. Complete freedom from common mode problems is possible on balanced input devices. Cross-talk is unusually low with the technique.

Circle No. 232 on Subscriber Service Card

## New Rate Gyro

A rate gyro using piezoelectric materials and advances in solid-state electronics has been developed by Arma Div., American Bosch Arma Corp. The G 14 will measure "angular rate" of drift or deviation in a wide variety of aircraft, space and missile applications. It is suited for use in flight testing, stabilization, automatic pilot and flight-control systems.

The G 14 has two-axis configuration that takes full advantage of the simple structure and large reaction torques of the conventional spinning rotor. The gyro rotor is centered in the structural rotor by two pairs of orthogonally-positioned rods. Piezoelectric cartridges sense changes in tension in these rods and provide the electrical output of the gyro. The output is a composite, two-axis voltage which is resolved in a narrow-band amplifier and two demodulators.

Circle No. 233 on Subscriber Service Card

## Helium-Cryopumped System

Arthur D. Little, Inc. has developed a helium-cryopumped space simulation system. The ADL Cry-Torr includes both nitrogen- and helium-cooled panels arrayed to provide cold black walls and rapid cryogenic pumping to meet the thermal and ultra high-vacuum requirements of second-generation space simulation chambers.

Cryopumping in the 250 cu. ft. chamber achieves pumping speeds of more than 150,000 liters per second for nitrogen gas and 1,000,000 liters per second for water vapor, both at $1 \times 10^{-8}$ torr. These pumping speeds have previously required large-scale chambers and the need for numerous diffusion pumps. Ultimate design pressure of the system is below $1 \times 10^{-9}$ torr.

Circle No. 234 on Subscriber Service Card

## Transistor Amplifiers

Compact dc amplifiers are available from Kane Engineering Laboratories. The instruments are for general use in electronic, chemical and aeronautical research and development. Carefully optimized transistorized circuitry assures accurate gain and low drift. Recovery from overload voltages is practically instantaneous. Full use is made of negative feedback advantages. Units are powered by two 9-volt batteries. Small test jacks are installed on front panels to allow battery checks. The amplifiers are non-inverting, i.e., positive input polarity yields positive output. A balance adjustment is provided to set zero output for zero input. A front panel switch permits the choice of two accurate, stable voltage-gain values of 2C and 4C db.

Circle No. 235 on Subscriber Service Card

## Quartz Oscillator

Improved accuracy in primary frequency and time standard is provided by a highly stable quartz oscillator available from Hewlett-Packard Co. The oscillator, Model 104AR, has a long-term stability of 5 parts to $10^{10}$ per day. Typical short-term stability, based on a 1-sec. average and reasonably constant environment is 5 parts in $10^{11}$.

Model 104AR provides a 5-mc output of extreme spectral purity. Because of this feature, the instrument is particularly useful for microwave spectroscopy.

Circle No. 236 on Subscriber Service Card





**RADARSCOPE RECORDING SYSTEM IN ONE-FIFTH CUBIC FOOT**

The Electro-Optical Department of CSC has developed a Radarscope Recording Camera System that simultaneously photographs radar images and records such data as time, range and directional orientation. CSC assumed responsibility for the design and production of this system from Bell & Howell Company about midway through the program.

Weighing less than 13 pounds, the system uses a negative lens to photograph a radarscope through a port at the rear of the cathode ray tube. A data chamber produces time-correlated information, reflected through a lens by two mirrors, for recording on the same frame of 35 mm film. Careful design for field use allows calibration and service without special tools. Assemblies can be removed easily and replaced quickly.

Electro-Optical, producing military and commercial cameras, optical systems and precision optics from conventional and exotic materials, is one of the divisions of CSC. Others design and build systems for analog and digital data handling, test-stand instrumentation and recording, precision pressure measurement, telemetry, and industrial control. For details on applications of custom systems in your area of interest, call your nearest CSC regional office or write:

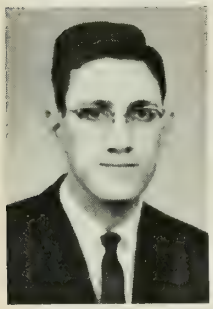
CONSOLIDATED

SYSTEMS

CORPORATION

1500 So. Shamrock Ave. • Monrovia, California

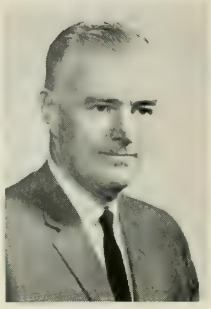
Circle No. 7 on Subscriber Service Card



ALEXANDER



DUNHAM



EGERTON



GODYCKI



FLEMING

**Robert G. Brown:** Named director of the *Titan II* program at the Milwaukee plants of the AC Spark Plug Div. of General Motors.

**Dr. Marvin H. Gold:** A leading rocket-propellant chemist, awarded the Navy Meritorious Public Service Citation for his contributions to high-energy rocket propulsion for advanced *Polaris*.

**George Alexander:** Appointed manager of United Technology Corp.'s new field office in Houston.

**Roger M. Daugherty:** Appointed manager of the Communications Dept. of Allen B. Du Mont Laboratories, Clifton, N.J.

**Dr. Harry J. Watters:** Appointed chief defense engineer, Defense Engineering, Radio Corp. of America, New York City.




ACROSS THE STREET FROM NASA—HOUSTON

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**Robert E. Dunham:** Appointed manager of contract sales for E. W. Bliss Co.'s Heavy Equipment Div., Canton, Ohio.

**Henry C. Egerton:** Appointed vice president of General Time Corp. and general manager of the Stromberg Div., Thomaston, Conn.

**Dr. Edgar A. Sack, Jr.:** Appointed engineering manager of the Westinghouse Molecular Electronics Div., Pittsburgh.

**Dr. L. E. Godycki:** Appointed manager of materials research for the Trimpot Div. of Bourns, Inc., Riverside, Calif.

**David M. Fleming:** Appointed assistant to the president at United Technology Corp., Sunnyvale, Calif.

**Leonard I. Matless:** Elected vice president in charge of engineering and design of Kelmore, Inc., Newark, N.J.

**Robert L. Stell:** First *Atlas* project officer at Cape Canaveral, joined Pan American World Airways Guided Missile Range Div. as manager of the *Pershing* and *MMRBM* programs and Project Fire.

**Wayne G. Norton:** Appointed vice president-general manager of Optical Gaging Products, Inc., Rochester, N.Y.

**Roy H. McGregor:** Appointed manager of aerospace marketing and contracts for Beech Products, Inc., Rochester, N.Y.

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**E. W. Shuster:** Named vice president of international operations for the E. W. Bliss Co., Canton, Ohio.

**Walter T. Banziger:** Named site director for installation of the new Strategic Air Command Control System at SAC Eighth Air Force headquarters, Westover, Mass.

**William H. Brearley, Jr.:** Appointed director of program management for the Aerospace Components Div. of Atlas Chemical Industries, Inc., Wilmington, Del.

**Dr. Urner Liddel:** Named chief of sciences for lunar planetary programs in NASA's Office of Space Sciences, Washington, D.C.

**Dr. James T. Waber:** Named recipient of the Willis Rodney Whitney Award for 1962, presented by the National Assn. of Corrosion Engineers. Dr. Waber is with the Los Alamos (N.M.) Scientific Laboratory Chemistry and Metallurgy research division.



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# when and where

## NOVEMBER

**Eighth Annual Conference on Magnetism and Magnetic Materials, IRE,** Penn-Sheraton Hotel, Pittsburgh, Nov. 12-15.

**Retardation and Recovery Symposium, sponsored by Aeronautical System Div.'s Flight Accessories Laboratory,** Imperial Motel, Dayton, Ohio, Nov. 13-14.

**National Symposium on Materials Compatibility and Contamination Control Processes, Society of Aerospace Materials and Process Engineers,** Hollywood Roosevelt Hotel, Hollywood, Calif., Nov. 13-15.

**Seventeenth Annual Meeting and Space Flight Exposition,** sponsored by ARS, Pan Pacific Auditorium, Los Angeles, Nov. 13-18.

**Mid-America Electronics Conference, IRE,** Hotel Continental, Kansas City, Mo., Nov. 19-20

**ASME Winter Annual Meeting,** Statler Hilton Hotel, New York City, Nov. 25-30.

**Western States Section Meeting, The Combustion Institute,** Aerojet-General Corp., Sacramento, Calif., Nov. 26-27.

**American Nuclear Society and Atomic Industrial Forum, Winter Meeting and Atom Fair,** Sheraton-Park and Shoreham Hotels, Washington, D.C., Nov. 26-28.

**American Institute of Electrical Engineers, Machine Tools Conference,** Statler Hilton Hotel, Detroit, Nov. 26-28.

**Environmental Testing Seminar, sponsored by Gulton Industries, Inc.,** Metuchen, N.J., Nov. 26-30.

**Radio Technical Commission for Aeronautics, Fall Meeting,** Marriott Motor Hotel, Washington, D.C., Nov. 27-29.

**Human Factors Society Annual Meeting,** Barbizon-Plaza Hotel, New York City, Nov. 28-30.

**1962 Ultrasonics Symposium, Institute of Radio Engineers,** Columbia University, New York City, Nov. 28-30.

## DECEMBER

**Vehicular Communications Conference, Institute of Radio Engineers,** Disneyland Motel, Los Angeles, Dec. 6-7.

**Unconventional Inertial Sensors Symposium,** Republic Aviation Corp., Farmingdale, N.Y., Dec 10-11.

**Symposium on Structural Dynamics Under High-Impulse Loading, sponsored by AFOSR (Mechanics Div.) and Aeronautical Systems Div.,** Wright-Patterson AFB, Dayton, Ohio, Dec. 17-18.

**Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science,** Philadelphia, Dec. 26-31.

**American Astronautical Society Symposium on Scientific Satellites-Mission and Design,** Franklin Hall, Philadelphia, Pa., Dec. 27.

## JANUARY

**Ninth Annual American Astronautical Society Meeting,** Statler Hilton Hotel, Los Angeles, Calif., Jan. 15-17.

**Ninth National Symposium on Reliability and Quality Control,** Sheraton-Palace Hotel, San Francisco, Calif., Jan. 22-24.

**Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Association,** International Inn, Washington, D.C., Jan. 28.

**Fourth Annual Solid Propellant Rocket Conference, American Rocket Society,** Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Pa., Jan. 30-Feb. 1.

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# Grumman to the Moon

AWARD of the Lunar Excursion Module contract to Grumman Aircraft Engineering Corp. marks the end of a bitter scientific dispute on the lunar program that went all the way to President Kennedy.

The manner in which the disagreement was conducted was not particularly appetizing, bordering at times on insubordination in public view.

Scientists certainly are obliged to back their own viewpoint on a subject as technical as this one. But it has seemed that everytime the lid was nailed down on the lunar orbital rendezvous mission, someone pried it open again.

In addition to their obligation to differ, the scientists on the NASA team who hold varying opinions also have an obligation to go along with an opposition decision once a firm commitment has been made.

This has not been the case. Despite a firm commitment from *Apollo* boss D. Brainerd Holmes to the LOR approach, the opposition case was carried to the President's science advisor, Dr. Jerome Wiesner, and to the President himself.

Top NASA officials found themselves in the uncomfortable position of having to defend their LOR decision to the President literally in mid-air, during his recent flying tour of space agency facilities. As a result, the final decision on the LEM contractor had to await White House approval.

NASA Administrator James Webb made it plain that he himself was making the final decision—but we wonder what would have happened if the White House, convinced by the opposition faction, had disagreed with Mr. Webb.

The timing of the announcement also leaves the award open to the charge that it was judged for political effect. This is not to say that Grumman won the award through politics. In fact, the truth was just the opposite. For some weeks, it has been reported that Grumman was first in the technical competition and ranked high in its management proposal.

But it was plain that announcement of the award to Grumman could not help the hopeless Democratic situation in New York, while the loss of the award could have had a political effect in other states—such as California and Maryland.

Holding of the announcement until the day after the election reduced its negative effect to a minimum. We certainly must congratulate the Administration on not using a contract as important as this as a political plum. But we do wish, somewhat naively, that the political strings did not show quite so plainly in the timing of the award.

WE WARMLY congratulate Grumman on its ability to win what has been one of the toughest competitions to date in the lunar program. This was a contest in which all of the entries displayed extremely high technical competence. We have had that assurance from Brainerd Holmes himself.

Grumman, preoccupied for years with the manufacture of extremely fine aircraft, has been one of the last of the airframe companies to move strongly into the Space Age. When it did make the decision, it went about the job with the same technical competence that distinguished its aircraft designs. There can be no higher testimony to that than the winning of the LEM contract against the most skilled opponents in the land, companies which got their start in space technology well ahead of the New York firm.

If the astronaut at the controls of LEM when it backs onto the lunar surface is a former Navy pilot, he most certainly will have full confidence in the vehicle he is flying.

We hope that confidence will not in any way be impaired by further scientific wrangling within NASA over the LOR approach.

Full study now has been given to the subject. There is no question that Earth orbital rendezvous and direct flight with a two-man spacecraft offer attractive alternative methods for a lunar landing. But LOR appears to meet all the safety and mission requirements, while offering substantial savings both in money and time.

The time lost would be significant if a shift now were made to another approach. For as long as beating the Russians to the Moon remains a national objective, this must be the guiding factor. Money is secondary—although, in this case, there also is a financial saving.

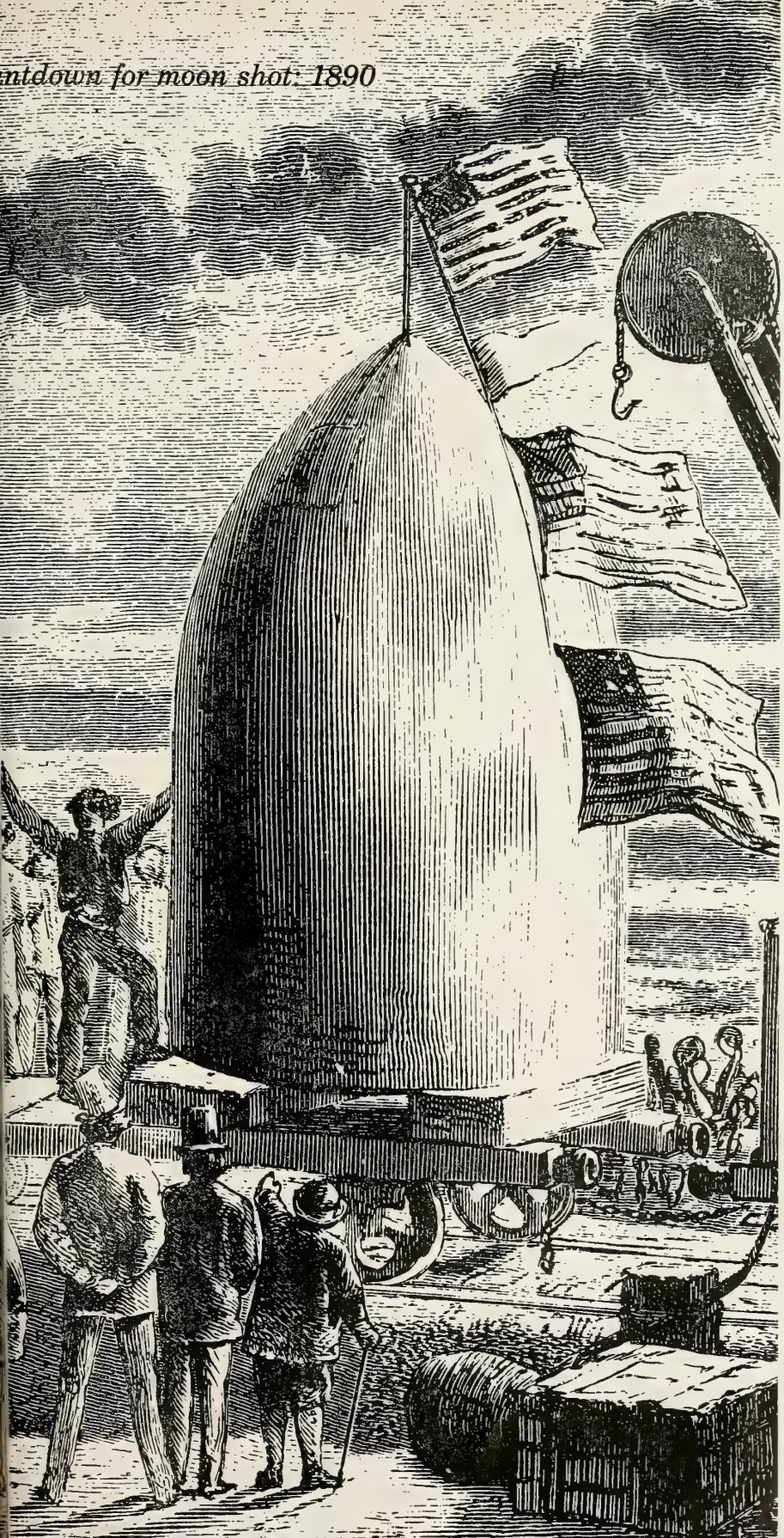
The President has stated the objective. Every effort must now be made to achieve it.

We hope that those within NASA and the White House who have questioned the LOR approach will now support it fully without further questioning. Continued haggling over the decision can only lead to delays which cannot be countenanced. Anyone on the team who is not prepared to give his fullest effort should resign and make way for someone who will.

This program is too important for petty bickering. It was just a year ago that the award of the initial *Apollo* contract to North American Aviation was announced. The fact that it has taken twelve months to reach the final decision on LOR is all the more reason it must now be given wholehearted support.

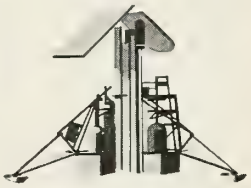
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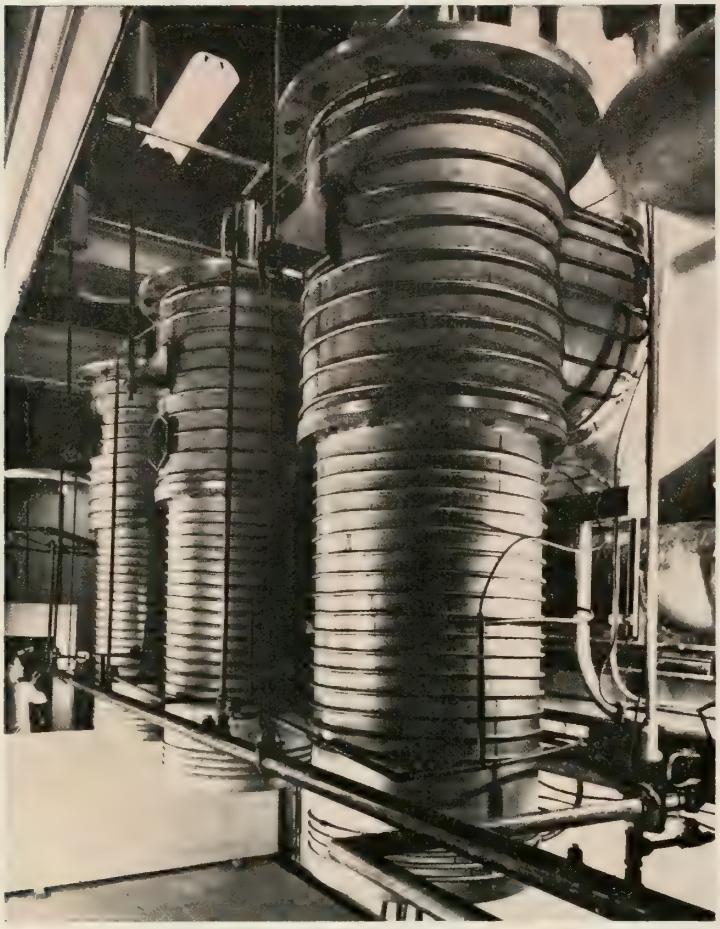
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# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 21 November 19, 1962

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## THE COVER

*Specially modified Carl Zeiss, Inc., planetarium projector is used at Morehead Planetarium, University of North Carolina, to give astronauts training in celestial recognition. See p. 28.*

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# letters

## The Ethics of Fame

*To the Editor:*

This is one of the best examples of a spanking that is sorely needed.

These men were selected from a large group of people and were weeded out of some pretty good patches. Maybe during the psychological examination they were not asked a very important question, i.e. What do you expect to gain by being a part of this team?

WW-II and Korea Veteran
(Name withheld)
Albuquerque, N.M.

*To the Editor:*

I read your editorial of Nov. 5 ("The Ethics of Fame") and can only comment that I was both amazed and saddened. (It) is such a perverted idealism that I would not be surprised to hear of you sitting on the bow of our next nuclear submarine or some equally naive act.

Your article centered about one main point: Some Americans have taken risks for their country, indeed have died for it, and have not made a personal financial gain from it. This argument, complete with irrelevant philosophical quotations, is inconclusively presented and passes from the sublime upon presentation to ridiculous at conclusion.

If the *LIFE* magazine pact had interfered with the astronauts' performance or the dissemination of data from their training or flights, NASA would undoubtedly have prohibited it. They did not. Comment on the pact was probably prompted by the fact that it is with *LIFE* and not with MISSILES AND ROCKETS.

It is only in a democratic nation that a man earning a five- or six-figure salary, sitting in a plush office and dictating to a pretty secretary, can berate another 'sitting atop tons of highly volatile rocket fuel' for trying to make life a little more comfortable for himself and his family. Why, in a country which thrives on capital investment, should the astronauts not be able to invest their money where they see fit? Does this create a conflict of interest? Only if we begin to orbit motels and apartment houses.

The final and most offensive of your invectives is that the astronauts have been allotted quarters at Houston too plush for their status. Here you are saying that men risking life and limb on a peacetime project are not deserving of a meager consideration over and above that granted a desk pilot of similar rank. Perhaps you think that they should live in the nearest BOQ?

If the editorial had been written after a mishap causing a crippling injury or death to one of them, the more emotional of our citizenry would justifiably favor orbiting you encased in a certain paving material and garnished with a pillow's innards.

The "manner and volume of our astronaut's dealings" are not improper but rather a testiment to their aptitude in fields other than space technology. If the press would spend more time considering the fine job these men are doing and less time on their finances, then their image would not have been tarnished in the first place.

Martin Brian Carey
Ft. Sill, Okla.

*To the Editor:*

Bravo!

Your editorial, "The Ethics of Fame," should be required reading for every youngster in the United States—who may yet be dissuaded from the conviction that the only way to serve one's country is to struggle, above all else, for the almighty buck.

Kudos for words well put, and above all else, for being ten feet tall by tackling a subject that is certain to gain you the unpopular vote by all those who have built altars of dollar bills.

Martin Caidin
Plainview, N.Y.

*To the Editor:*

I write this letter in protest to your editorial "The Ethics of Fame" in the Nov. 5 issue of MISSILES AND ROCKETS. It seems to me as if this attack on the U. S. astronauts was written in haste, and not given even superficial consideration. The reader can find nothing but revulsion in the write-up, which criticizes a sale to *LIFE* in column one and admits that there is nothing wrong with this sale in column two. Come off this crass commercialization crap, Coughlin!

Your writing appears designed for an appeal to the reader's emotions rather than his reason. Undoubtedly you are a gifted pensman; witness your recounting the tales of American heroes Messrs. Bailey, Bong and Lynch, and your quoting the ancient greats Aristotle and Seneca. But I ask you this question sir—do you think that any of these men would agree with your assertion that the U. S. astronauts have shown a singular lack of character?

I dispute your claim that our heroes have feet of clay and that they have failed in honor and reputation. What kind of warped logic is this?

You have publicly lambasted seven American men who are serving their country. It's too late to undo all the damage, but there are some things that could be done to correct this injustice. Won't you put aside your bottle of bile and dip your pen in some honest ink. How about it?

Al Roloff
Melbourne, Fla.

*To the Editor:*

It takes great courage to swim upstream, as you did in your editorial of Nov. 5. But we're glad SOMEBODY finally said it publicly!

Lucien R. Grief
Patrick AFB, Fla.


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*To the Editor:*

According to your editorial "The Ethics of Fame", the trouble with the Astronauts is that they aren't perfect. Come now, aren't you being a bit supercritical? Of course, they are not perfect. This certainly doesn't mean that they deserve a public dressing down from a magazine that perhaps may not be perfect either.

I will agree that the hero that can turn down all offers of tangible reward for his heroism is a wonderful thing to behold, but this doesn't lessen my admiration and respect for another brave man who does capitalize to some extent on his fame. Stan Musial has a restaurant. He is capitalizing on his many and noteworthy achievements. Does this make him less a man? I think not.

When the Astronauts volunteered for their mission, they could be sure of only one thing. They faced years of hard work, great mental stress and great physical danger. They were promised nothing and they asked nothing. Later when they did have an opportunity to receive some financial rewards, they accepted the opportunity. In your business and in my business, this is called good common sense. So it is with our Astronauts. No, they are not perfect, but wouldn't their state of imperfection be a most worthy goal toward which we could all strive?

Harold E. Pryor
Palos Verdes Estates, Calif.

## Rebutting Blough Support

*To the Editor:*

The expressions of dismay and indignation that have appeared recently in these columns and in your well-written editorial concerning President Kennedy's action during the recent contractural efforts of the steel industry display only one side of the coin. Permit me to show the other side and offer a rebuttal.

Statements by President Kennedy to both labor and management prior to the settlement of the steel contracts clearly included requests not to demand a wage increase by labor and not to invoke a price increase in steel to management. The replies were interesting in that labor stated an agreement to the President's request while management appeared to agree but made no statement so specifying.

On the other hand by not voicing disagreement then, by implication management agreed not to raise prices. Mr. Blough and company had an obligation to the country to state their position before the completion of the contractural efforts. The absolutely flagrant disregard of the President's appeal in Blough's crass attitude brought upon big steel the result fully deserved.

Since the steel industry was not running at full capacity, (and currently isn't either) the price increase was all the more peculiar and uncalled for. The paper losses in the stock—those who didn't fly off the handle and foolishly sell haphazardly did not lose a dime—have had a salutary effect on an overpriced market. For me, I applaud the President's action in this case.

Saunders B. Kramer
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# The Countdown

## WASHINGTON

### Project Pandora's Box

Defense Dept. is complaining that the services have swamped it with requests for project go-aheads since the removal of arbitrary budget ceilings. DOD Comptroller Charles Hitch says "virtually every project which could conceivably have any merit at all"—including many which had been turned down earlier—was submitted during the FY 1964 budget review. Pentagon does not now plan to re-impose ceilings, but may start program reviews early so the services will know what they can get away with before the first formal budget review in October.

### Nike-Hercules on Cuba Watch

*Nike-Hercules* antiaircraft missiles have been emplaced in southern Florida to counter the continuing threat of Soviet Cuba-based IL-28 bombers. *Hawk* units were moved into the area earlier, but a recent photo was the first indication (DOD has yet to confirm it) that the higher-performance *Hercules* was also deployed.

### Saturns to Spare

NASA estimates that by the mid-'60's it will be able to produce 12 advanced *Saturn* launch vehicles per year. Project *Apollo* probably will need three or four a year, leaving the remainder available for other manned and unmanned missions.

### NASA Jurisdictional Dispute

A battle is shaping up between two NASA divisions—Goddard Space Flight Center and Ames Research Center—as to which will manage certain future unmanned scientific probe programs. Assignments won't be resolved for another year or two.

### New Cooperation Plan Weighed

Some State Dept. officials are pushing a new plan which would radically change the structure of the U.S. international space cooperation program. Under the proposal, the U.S. would switch from signing bilateral agreements. Instead, emphasis would be placed on pacts with regional space groups comprising several countries.

### Orion Still Hanging Fire

Air Force is still reportedly "backing and filling" on Project *Orion* (M/R, Oct. 29, p. 28), with a decision still "expected any day." AF must get the program approved by Dept. of Defense Director of Research and Engineering, which apparently is not very enthusiastic about the bomb-powered vehicle. DDRE refuses to discuss the project, referring questions to the Air Force.

## INDUSTRY

### Telstar II Supernumerary?

There's a very good chance AT&T will scrap its plans for a second *Telstar* communications satellite, although the final choice won't be made until next year. *Delta* launch vehicle for the second shot was used by NASA recently to launch *Explorer XV*. Meantime, AT&T is getting so much data from *Telstar I* that company officials are seriously considering dropping the second flight from the program.

### What's Good for Space . . .

Space is becoming the nation's biggest economic enterprise. Dr. Edward G. Welsh, executive secretary of the National Space Council, predicts that several million persons will be employed in space projects and related industries within a few years. This compares to 800,000 employees in the U.S. automotive industry last year.

### Contracting Report at Hand

A special committee studying NASA contracting policy is expected to make its report—primarily dealing with new contractor source selection procedures—to Administrator James E. Webb early in December. Changes will be effective Jan. 1.

### A Bridge for Canaveral

The Corps of Engineers' Jacksonville, Fla., office will open bids Dec. 13 for construction of a $2-million, six-mile-long causeway to connect the Cape Canaveral and Merritt Island industrial areas.

## INTERNATIONAL

### Sidewinders to Siam

It hasn't been announced in the U.S., but Thai officials have revealed that their aircraft will be equipped with American-furnished GE/Philco *Sidewinders*—the same missiles used so successfully by Chinese Nationalist pilots against Communist Chinese aircraft over the Formose Straits.

### France Builds Atomic Strength

France seems to be making significant strides in its drive to create a nuclear striking force. By 1964, it will have Mirage IV fighters equipped with atomic weapons with a yield of 60 kt; by 1967, its first nuclear-powered missile-firing submarine is expected to be in service, according to a French military leader, Rear Adm. Adolphe Lepotier.

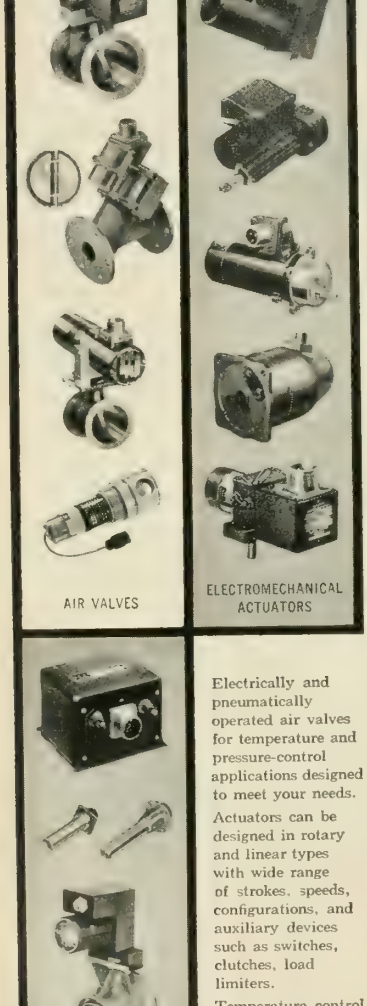
### Blue Steel Reprieve Considered

Britain may hang onto its *Blue Steel* missile beyond 1965, when it was expected to drop it in favor of the Douglas *Skybolt*. It's now doubtful whether *Skybolt* will be ready for the British by that time, and recent *Blue Steel* trials at Woomera have been highly successful. *Blue Steel* has a much shorter range, but could be useful against certain targets.

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# The Missile/Space Week

## Cooper to Pilot MA-9

Astronaut L. Gordon Cooper has been designated pilot for the next U.S. manned orbital space flight.

The *MA-9* flight, scheduled for April 1963, will be an attempt to extend the duration of U.S. manned orbital flight around the Earth to about one full day. No decision has been made as to whether 16, 17 or 18 orbits will be made.

Cooper, a 35-year-old Air Force major, acted as backup pilot and technical advisor for Astronaut Walter M. Schirra during preparations for the six-orbit flight of the *Sigma 7* Oct. 3. Astronaut Alan B. Shepard will act as backup pilot for the *MA-9* flight.

The *MA-9* flight will be an attempt to accomplish the sixth manned spaceflight of the continuing U.S. manned spaceflight research program directed by National Aeronautics and Space Administration. The *MA-9* spacecraft has already been delivered to Cape Canaveral where it is undergoing preliminary tests and checkout.

NASA said the flight is planned for April because unfavorable weather conditions in the Cape Canaveral-Atlantic area normally extend through the first quarter of the year.

*MA-9* may complete the *Mercury* flight series. A second shot is planned, but it may be dropped if *MA-9* is successful.

## Saturn Shot Tests Guidance

NASA's third launch of its *Saturn* booster will be highlighted by preliminary tests of an improved guidance system.

The space agency announced that the *SA-3* flight would be attempted late last week, with Nov. 16 set as the earliest possible launch time.

The first two launches in the *Saturn* series, Oct. 27, 1961 and April 25, 1962, were both successful.

*SA-3*, while similar to the first two flights, will provide the first test of the ST-90 stabilized platform of the vehicle's guidance and control system.

The booster will also carry a full load of propellant for the first time.

Ten development flights are planned for the *Saturn* vehicle. Main objective of the first four is to test the first-stage cluster of eight H-1 engines. Tests of the two-stage vehicle will begin with *SA-5* in the last half of 1963. The second stage is powered by six RL-10A3 liquid hydrogen engines.

Primary mission of the *Saturn C-1* is the launching into Earth orbit of the three-man *Apollo* spacecraft. These flights are scheduled for late 1964 and early 1965.

The *SA-3* vehicle is 163 ft. high, with maximum diameter of 21½ ft. It will weigh about 1.1 million lbs. at liftoff. In the early flights, the H-1 engines are rated at 165,000 lbs. thrust each. For flight five and thereafter, they will generate 188,000 lbs. thrust each, for a stage thrust of 1.5 million lbs.

The booster will carry a full load of propellant, some 750,000 lbs. instead of the 620,000 lbs. of *SA-2*. Engine burning time will extend about 30 sec. The four inner engines will cut off about 140 sec. after liftoff, and the outer engines about seven seconds later.

This performance would carry the rocket to a maximum altitude of 104 mi., instead of the 85 of *SA-2;* a range of 270 mi. instead of 225; and a velocity of 4000 mph instead of 3600. Flight time to impact would be slightly more than eight minutes.

Other major changes from *SA-2* include:

—An engineering model of the ST-124 stabilized platform which is to be a major component of the final *C-1* guidance scheme will be carried on the flight. The stabilized platform will be instrumented and its performance monitored throughout the flight, but it will have no control over the vehicle. It will be located in an instrument canister between the *S-1* and *S-IV* stages.

—Two small plates or panels are mounted on the payload-adapter section above the inert third stage. This is a dynamic pressure study conducted in support of the *Centaur* vehicle program. Eleven special measurements will be taken to determine the amount of pressure experienced and the rate of build-up.

—First-stage retro rockets which will be used on later launchings will be tried on *SA-3*. The four solid-propellant retro rockets, mounted at the top of the booster with nozzle upward, will be fired about 12 sec. after inboard engine cutoff, but there will be no separation of stages.

The *Saturn C-1* booster was static-fired for the first time for its full duration and at full thrust Nov. 9, according to officials at the Marshall Space Flight Center.

The firing lasted 115 sec. and the *S-1* stage developed a thrust of 1.5 million lbs. Previous firings had attained thrust levels of only 1.3 million lbs. Two full thrust tests had been conducted previously for 30 and 60 sec.—a little more than half the full duration.

## Shots of the Week

After an emergency landing at Mud Lake, Nev., Nov. 9, an *X-15* piloted by NASA's John McKay blew a tire on its nose wheel and tumbled wing-over-wing, finally coming to rest upside down.

McKay was pulled from the wreckage by paramedics and flight surgeons and rushed to the hospital at Edwards AFB, Calif., for observation. He reportedly escaped unhurt from the crash.

The *X-15* had been forced to make the emergency landing when it developed pressure trouble shortly after drop from a B-52 over Mud Lake. McKay made a perfect skid landing on the dry lake bed and appeared to have the ship under control until the nose wheel collapsed.

It was the third such crash landing by an *X-15* in 74 flights. The first occurred Nov. 5, 1959 during the plane's second flight with Scott Crossfield at the controls. After landing on Rosamond dry lake bed, the *X-15's* fuselage broke in two.

The second emergency landing, also on Mud Lake, took place last Jan. 10 when Navy Commander Forrest Petersen's plane developed engine trouble.

The aborted flight by McKay was one of a series designed to test the reentry stability of the *X-15* without its ventral fin.

One of three research aircraft, the wrecked *X-15* is not expected to be rebuilt because damage was too extensive.

• An *Atlas F* was successfully fired from an underground silo at Vandenberg AFB on Nov. 14. It was the second successful launch from underground for the Air Force ICBM.

• A pyramid-shaped satellite—the smallest ever launched by the U.S.—has been placed into an unspecified orbit by the Air Force to measure the increased radiation caused by the July 9 U.S. high-altitude nuclear test.

Secretly launched piggyback from Vandenberg AFB, Calif., the tetrahedral research satellite *(TRS)* is 6½ in. on a side and weighs slightly less than 1½ lbs.

It is equipped with radiation detection instruments, batteries and a radio transmitter to map space radiation. Five more *TRS* satellites are expected to be used in similar missions.

• The Army announced last week back-to-back successes in test firings of its *Nike-Zeus* antimissile missile. The first success Nov. 8, at White Sands Missile Range, N.M., was a test of "the most recent configuration" of the *Zeus*. The same day at Pt. Mugu, Calif., a *Zeus* successfully intercepted an electronically simulated ICBM. No actual target vehicle was involved in the test, Army officials stressed.

• Testing of the improved *Quail* (GAM-72B) was concluded Nov. 6 with the successful launch of the missile from a B-52 over White Sands Missile Range. The test brought to a close nearly four years of development tests on the *Quail* by the Air Proving Ground Center, Eglin AFB, Fla.

## Apollo Engine Fired

Aerojet-General reported it has carried out several successful firings of its *Apollo* development engine.

The company said last week a prototype of the storable liquid-fueled powerplant was recently fired for checkout runs up to 50 sec. A test run totaling 1020 sec. has been conducted with a sub-scale model, Aerojet added.

Chamber ablation rates were reported to be well below the maximum allowable.

## Mariner Regains Power

As mysteriously as it was lost, solar power to the *Mariner II* spacecraft was regained last week. JPL scientists still do not know why the power level dropped from the normal 250 watts to 156.2 watts, but they have reported that it returned to normal.

The four interplanetary experiments turned off to conserve power more than a week ago have been turned back on by a signal from the DSIF network. The two planetary science experiments to study Venus will be turned on automatically 10 days before Venus fly-by Dec. 14.

At present, 147.5 watts of the solar power system's 250 watts is being consumed by the interplanetary experiments and 52 channels of engineering telemetry.





A new avionics system now under development at Hughes is designed to increase the U.S. Navy's airborne ASW effectiveness through data processing, central computation, sensor integration and more accurate navigation.

Urgent and immediate requirements exist on this program for Senior Engineers and Physicists with applicable backgrounds to assist ASW Laboratory Project Managers at the System level.

BS or advanced degree from an accredited university and U.S. Citizenship are required. Interest, training and experience should include: (1) an extensive background in analysis and evaluation of airborne ASW weapon systems, and/or (2) several years of technical experience in the analysis and generation of digital computer programming and software.

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## NASA To Test Space Taxi

Tests of a "lifting body" re-entry vehicle are expected to begin at Edwards AFB, Calif., in January or February of next year.

Based on designs developed at Langley and Ames Research Centers, the half-conical re-entry body with control surfaces on the blunt end will initially be towed aloft behind a truck. Later a small plane will be used to tow it up to an altitude of 5000 ft. where it will be cut loose and allowed to glide back to Earth.

An advanced version with its own rocket engines may be developed to be carried by a B-52 to 45,000 ft., where it would be dropped at supersonic speeds to test its stability.

The goal of the program is to develop maneuverable re-entry vehicle shapes which can return safely from orbit and can be used as a "space taxi" between orbital vehicles and the ground.

The "lifting body"—to be test flown by NASA test pilot Milt Thompson—weighs about 500 lbs. and is 13 ft. across, 7½ ft. deep and 24 ft. long.

## GD Faces Antitrust Suit

The Justice Department has filed suit against General Dynamics Corp. in an effort to force the firm to divest itself of its Carbon Dioxide Division.

The suit claims GD used its purchasing power to force its customers to buy $CO_2$ from GD. The charges allege the firm's procedures violate the Sherman and Clayton Antitrust Acts.

The complaint said GD has about 29% of all domestic sales of $CO_2$ in addition to what it produces for its own use, and that the company's acquisition of Liquid Carbonic Corp. in 1957 lessened competition and created a monopoly.

The government also charged that GD set up a special sales program in 1958 to force its suppliers to buy from it.

## Scientist/Astronauts Urged

First public disclosure of plans for establishment of a scientist/astronaut training program were released by Dr. James A. Van Allen at the NASA-MIT-sponsored meeting on space science and technology held in Boston last week.

The proposal for establishment of a training site, probably adjacent to the Manned Spacecraft Center at Houston, is contained in a report covering studies made this summer at Iowa State University in a program on the nation's scientific space projects attended by some 250 leading scientists.

According to Van Allen, the report strongly recommends rapid integration of qualified scientists—primarily geologists, biologists and physicists—into the nation's astronaut training program in various scientist-astronaut capacities.

Van Allen says the report recommends that scientists be included if at all possible in the *Apollo* flight crews, with actual flight training possibly beginning in the *Gemini* series. He later conceded that this might be too difficult a date to meet.

Two years would be required for training the scientists as astronauts. The report recommends that the institute be in progress by August 1963.

No firm statement was given regarding NASA approval of this program, but Van Allen indicated that most of the recommendations made under the study and submitted to NASA in August have already been fed into NASA's future plans and that the space agency was "very sympathetic" to the scientist/astronaut program.

## Lerom Dies in Crash

Brig. Gen. John I. Lerom, (USAF-Reserve), Manager of Washington Operations for United Technology Corp., died in an aircraft crash on a Tennessee mountain top Nov. 10.

Before joining UTC in 1961, Lerom was with the General Electric Aircraft Nuclear Propulsion Dept. Previous posts were with the Civil Aeronautics Administration, Office of the Secretary of the Air Force and as a member of the U.S. Civil Aviation Mission to Panama.

The Editors of MISSILES AND ROCKETS join the numerous friends of John Lerom in industry, the military and government in extending their deepest sympathy.

## IAM Letter Blasts Lockheed

The International Assn. of Machinists has accused Lockheed Aircraft Corp. of "trying to provoke a strike in total disregard of the national interest."

In a letter to President Kennedy, IAM official E. R. White reported a new breakdown in negotiations between Lockheed and the union, and indicated workers will hold a strike vote Nov. 18.

White called the company's management "adamant" and "arrogant" in turning down the most recent union proposal, which White said involved acceptance of "economic guidelines" recommended by a Presidential fact-finding board, and submission to arbitration of non-economic issues.

"The only real issue," a Lockheed source told M/R, "is that of a union shop, subject to two-thirds employee vote of endorsement." Lockheed opposes such a vote.

Similar polls in several missile/space firms recently ruled out the union shop, despite union campaigns for it.

"The IAM letter was to be expected," the source said. "It was not the first union note to the President, and it is unlikely to be the last." He referred to IAM's demand that Kennedy order government take-over of Lockheed "in the national interest" at the height of the Cuban crisis unless the firm yielded to certain union demands to avoid a strike.

## Atlas Base Operational

An *Atlas F* squadron at Dyess AFB, Abilene, Tex., was declared operational last week by the Strategic Air Command. The 12-missile base was turned over to SAC by Col. H. B. Manson of the Site Activation Task Force at Dyess.

The base will be manned by SAC's 96th Strategic Aerospace Wing and will be part of the 15th Air Force with headquarters at March AFB, Calif.

## Sane Space Policy Asked

A "politically sane" program of U.S. space development was urged last week by Lincoln P. Bloomfield, an associate political science professor at the Massachusetts Institute of Technology. Speaking before a New England Regional Space Conference in Cambridge, Mass., he said that such a program would relieve growing world tension over the possibility of thermonuclear weapons in orbit.

In the development of a space policy, Bloomfield said, "we must not allow those whose concern is exclusively with military hardware to overwhelm our sense of policy perspective."

Sound strategic doctrine, he emphasized, holds that thermonuclear weapons in orbit are "unnecessary

and even vulnerable, compared with weapons buried underground or deployed in submarines."

Dr. Julius A. Stratton, president of MIT, told a conference luncheon meeting that the institute was continuing a study to create a center for space sciences to coordinate and expand the resources already available at MIT.

The two-day conference was sponsored jointly by MIT and NASA.

## GE Forms Apollo Unit

General Electric Co. has set up a technical team to fulfill its role of systems integration and checkout for the manned lunar landing program.

Located in Daytona Beach, Fla., the *Apollo* Support Department will be headed by Richard L. Shetler, former general manager of GE's Command Systems division. Program director for the department will be John K. Records, former head of the GE team that developed the *Atlas* guidance system.

Program manager of reliability assessment is Robert S. Grisetti, head of advanced engineering for the *Atlas* radio-guidance project. Other appointments include: Dr. Lindon E. Saline, checkout manager; James E. Keister, manager of southeast support operation at Cape Canaveral; L. W. Warzecha, manager of support operation at the Manned Spacecraft Center.

E. A. Wright, manager of support operation at Marshall Center; Robert G. Henry, manager of program operations; Robert D. Featherhouse, manager of finance at Daytona and Walter B. Booth, employee relations manager at Daytona.

## AF Sets Up Staff Agency

A Directorate for Command Control and Communications has been established within the Air Staff, AF Vice-Chief of Staff Gen. W. F. McKee announced last week.

Made up from resources within the present Directorate of Telecommunications, the new staff agency will retain the functions and responsibilities formerly assigned and will be the focal point within the Air Staff for all matters pertaining to command control.

Included in these responsibilities will be monitoring the functional and technical design of the USAF command control system and its integration with the National Military Command System (NMCS).





## *Homeward Bound Red Rockets*

*RECENTLY RELEASED Defense Department photos show Soviet missiles being shipped home from Cuba. At top, one apparently uncovered missile is visible on the foredeck of the Russian ship Volgoles. Covered missiles are astern. Moving alongside Volgoles is U.S. Navy radar picket ship Vesole. Bottom photo is of Soviet ship Bratsk, with two missiles on afterdeck. Canvas covers have been removed, revealing casing which protects weapons against corrosion.*

## Space Goals Group Proposed

An Advisory Commission on National Space Goals and Means has been proposed by Ladd Plumley, president of the U.S. Chamber of Commerce, to determine the impact of the space program on the nation over the next 10 to 20 years, and to advise the President and Congress.

Describing the group as an "examining, analyzing and recommending body," Plumley said it would be bipartisan and non-political, and would contain scientists, economists, military, businessmen, educators, labor, congressmen, theologians and philosophers. Financing would come from a private source such as a foundation.

## Moffett Chosen for RIFT

A former dirigible hanger at Moffett Naval Air Station has been selected as the manufacturing site for the RIFT (Reactor-In-Flight Test) stage under development by Lockheed Missiles & Space Co.

Although NASA and Lockheed refused to comment, terming the announcement "premature," Congressman Charles S. Gubser (R-Calif.) revealed the selection in an interview last week.

Conversion of the hanger to handle the nuclear rocket stage is expected to cost $10 million, while by using existing facilities, some $20 million will be saved. The Moffett hanger is only a short distance from Lockheed's Sunnyvale plant.

## Lunar Photos Released

Photos of the moon's surface taken by the 200-in. reflecting telescope at Lick Observatory near San Jose, Calif., were released last week showing the lunar surface "with probably unequaled clarity."

Included in Lick's "catalogue of astronomical photographs," the pictures were described by a University of California spokesman as a "fortunate result of excellent seeing conditions . . . precise optical and guidance systems, high magnification and skilled use of modern astrophotographic techniques."

# Manned Programs Keynote ARS

## *Society's first annual meeting on West Coast produces superior exhibition emphasizing future projects; some technical highlights*

LOS ANGELES—Hardware and systems engineering for the rapidly expanding U.S. manned space program dominated the 1962 American Rocket Society annual meeting and exhibition here.

From tiny Project *Gemini* explosive ordnance devices to full-scale boilerplate models of the *Apollo* command and service modules, primary attention at the meeting was focused on advanced manned space efforts.

The exhibition itself—some 10 to 15% smaller than last year's New York show—drew praise from many observers for its increased usefulness in the technical field. Working models, lectures and demonstrations far outnumbered simple display exhibits.

New technical development unveiled at the four-day meeting included:

• Aerojet-General's variable-thrust injector designed for application to the storable-propulsion system of the Lunar Excursion Module and other spacecraft (see box, p. 17).

• Two new general-purpose fast-operating digital computers for space use, weighing only 20 lbs. each—Librascope's L-90 and Minneapolis-Honeywell's Pico.

• A three-axis cryogenic superconducting accelerometer appropriate for high-accuracy inertial guidance application, developed by Minneapolis-Honeywell.

• An airborne computer utilizing magnetic thin-film memory and welded cordwood circuitry, Univac's 88-lb. ADD (Aerospace Digital Development).

• A two-way Bendix portable communication system contained in a belt-pack telemetry unit and capable of transmitting voice or telemetry data from an astronaut either inside or outside a space vehicle.

• Martin Co.'s proposal of a two- or three-stage *Pegasus* space probe booster capable of lifting payloads of from 50 to 2000 lbs. to altitudes of 100 to 3000 n. mi.

• Swedlow Inc.'s announcement of a new form of high-pressure containment for production of rocket nozzles up to 400 in. in diameter and of a new filament-winding system for large rocket motor cases.

Lasers and masers drew major attention at the show. Among the exhibits were Lear Siegler Inc.'s demonstration of laser welding, a showing of Hughes Aircraft's Model 200 ruby laser series, and a display of organic laser rods by Electro-Optical Systems. A model of a gaseous optical maser for voice communication was displayed by Bell Telephone System.

The U.S. Air Force exhibit featured a manned and unmanned satellite inspection system and aerospace plane. Other exhibits of interest included Marquardt's working model of the Lunar Excursion Module rendezvousing in space with *Apollo*, General Electric's full-scale *Nimbus* meteorological satellite, Atlantic Research Corp.'s pressurized-freon thrust-vector-control system for *Polaris*, Hercules' huge 13-ft. filament-wound solid motor case and Allis Chalmers' golf cart—powered by a 3-kw. fuel cell.

*Coverage of the American Rocket Society meeting in Los Angeles was provided by a* MISSILES AND ROCKETS *editorial team which included editor William J. Coughlin, Senior Editor Charles LaFond and Associate Editors Russell Hawkes, Richard van Osten and Willard E. Wilks.*

Minneapolis-Honeywell said its new Pico computer, which has a 46-watt power requirement, is built around a solid-state biaxial non-destructive readout ferrite core. A complete 24-bit add cycle, including access time, can be completed in 12 microseconds. Its memory can be expanded from a basic 3072 words to 8192 words by stacking additional memory planes. Memory planes are enclosed in a separate sealed case which plugs into the rest of the computer. A single logic clock and a single acculumator have been utilized with the non-destructive memory.

• **Computer advances**—The Pico computer is designed to withstand temperature extremes from −55°C to 100°C, and the entire case can be sealed and filled with an inert gas for orbital use. The company said the computer is designed so that its capabilities can be reduced or increased as required without redesign.

Librascope Div. of General Precision Inc. said its L-90 operates at a 20-megacycle clock rate, contains an 8192-word permanent memory, and consumes 30 watts of power.

Extensive use of semiconductor microcircuits has resulted in less than 1200 electronic parts, Librascope said. It gave temperature range performance of the L-90 as −55°C to 125°C.

Univac said the minimum reliability objective for its ADD thin-film computer is an average operational time of 10,000 hours, or over one year of continuous operation under extreme conditions of environmental stress. It is designed to fulfill total requirements of any system as the single central control computer. All but a small portion of the ADD memory is of a non-destructive readout nature.

• **Astronaut gear**—The belt-pack data communication system designed by




*APOLLO MOCK-UP outside ARS exhibition at the Pan Pacific Auditorium.*

Bendix-Pacific Div. will transmit seven different types of physical information in addition to voice. The belt pack consists of three small units, each about three inches square, mounted on webbing. Probes connect with the astronaut's body. Power is furnished by small rechargeable nickel-cadmium batteries.

• **Booster entry**—Martin Co. said its *Pegasus* booster concept is designed as a transportable system for component and subsystem testing; high-altitude probes; zero g, vacuum and acceleration testing; photo or flare mapping; reconnaissance, surveillance and re-entry testing. Cost would be highly competitive with other space probes, Martin said.

• **Cable wrapping**—Swedlow's Cable-Clave process for high-pressure containment in large nozzle manufacture is said to eliminate the need for hydroclaves by substituting steel cables for the usual steel-cased pressure vessel.

Reinforced-plastic material is wound on a metal mandrel. Two layers of rubber, sealed at the nozzle ends but not attatched to the assembly, are placed over this. Thin metal strips are added to protect the rubber and the entire assembly is wrapped with steel cable. A high-pressure pump is attached to inject water pressure of 1000 psi between the layers of rubber. With the pressure sandwiched between the mandrel and the cabling, the plastic layer is subjected to full pressure during cure.

The entire unit can be machined and wrapped with no need to move the nozzle into and out of a pressure vessel, the company pointed out. Swedlow said the process permits unrestricted freedom for increase of nozzle size.

Swedlow's new case-winding system employs a winding machine to operate around the motor case, which does not revolve. The system will wind both longitudinally and circumferentially, according to Swedlow.

### Technical Papers

A PREVIEW of "The U.S. Standard Atmosphere, 1962" was given at the ARS meeting by scientists from Air Force Cambridge Research Laboratory, NASA and the U.S. Weather Bureau who participated in its design. The new publication extends atmospheric standard values to an altitude of 700 kilometers and is oriented toward space activities. It replaces the 1956 "U.S. Extension of the ICAO Standard Atmosphere," which reached only to an altitude of 300 kilometers.

The new standard atmosphere is expected to be useful for calculation of satellite orbit decay, prediction of acoustic paths from high-altitude nuclear explosions, and other purposes. It will be public by the end of the year.

Research since 1956 has indicated that temperatures at 300 kilometers are 500 degrees warmer than indicated in the old standard; the change is recorded in the new publication along with associated changes in density and other characteristics. New types of information, such as the range of departures from standard, are now included. For instance, in the lowest 90 kilometers of the atmosphere, density can vary by as much as 60%.

The earlier standard gave values for geopotential altitude, which is a reasonable approximation of geometric altitude up to the 20-kilometer top of the basic ICAO standard. It was necessary to convert to geometric altitude for the 1962 standard because the difference between the two increases with altitude and amounts to 70,000 meters at the 70-km top of the new standard.

The new density curve is a daytime mean for a range of solar activity midway between sunspot maximum and sunspot minimum. However, space research has shown that diurnal variation of actual density can amount to as much as 100% at 700 kilometers, because of deepening of the atmosphere caused by thermal expansion under solar radiation and contraction in its absence.

A section of the standard will relate data for altitudes above 200 kilometers to the position of the Sun. Standard density at 700 kilometers is about two-thirds the older value because it represents an average between quiet and active Sun conditions. The earlier standard was selected during a time of intense solar activity.

*(Continued on next page)*

# Asides at the ARS Meeting

HYBRID attitude-control rockets burning gaseous oxygen and plexiglass (polymethyl methacrylate) have been proposed to ComSat prime contractors and NASA by United Technology Corp.

UTC engineers first made plexiglass-fueled hybrids as demonstration devices, since the method makes combustion visible. Experience proved it had substantial advantages for some low-thrust space applications. The maximum thrust obtained to date is 100 lbs.

At high thrust levels, these rockets tend to be too long and narrow because of the low recession rate of the combustion surface in plexiglass. However, the same trait produces a long burning time for a given thrust level, so that the fuel web need not be unduly thick in small engines.

UTC has found that the plexiglass/oxygen rocket and all other hybrids function best with plug nozzles, which retard flow in the center of the charge port, producing better mixing between the oxygen-rich center and the fuel-rich boundary layer. As part of the proposal on the ComSat attitude control system, UTC will soon try a 1000-sec. firing of one of the oxygen/plexiglass systems. The fuel grain has not yet been designed, but is likely to be slightly conical. The oxygen injector is a simple hole in the head of the case and the charge port is circular.

Theoretical combustion temperature of the propellant combination is 6600°R. Combustion is started by injecting a squirt of propane with the oxygen and igniting it with a spark plug. Performance is claimed to be comparable to that of nitrogen tetroxide and hydrazine. A special advantage for the ComSat application is the fact that the propellant combination produces no soot to fog up solar cell surfaces. Combustion products are carbon dioxide, water, and a negligible amount of carbon monoxide. Use of gaseous oxygen under high pressure eliminates the need for a separate propellant pressurization or pumping system and has some advantages for the three-year storage times being specified.

• Early returns in the election to combine the American Rocket Society and Institute of Aerospace Sciences into the American Institute of Aeronautics and Astronautics are running heavily in favor of merger. With some 40% of the ballots in, ARS figures indicate an 85% approval. IAS figures are said to be even more favorable for merger.

• Avco's Mark II re-entry vehicle for *Minuteman* is much more sharply pointed than the earlier vehicle. The design cuts down the radar cross-section.

• General Electric's ARS display included a mockup of the firm's target re-entry vehicle for the *Nike-Zeus* program. The vehicle carries a miss-distance indicator.

• A 76-in.-deep extruded motor case of 5A1-2½Sn titanium alloy is under development at Wayman-Gordon's Grafton, Mass., plant for possible use as a casing on the *Nerva* nuclear rocket.

• The American Rocket Society's highest honor, the Goddard Memorial Award, went this year to Robert Gilruth, Director of NASA's Manned Spacecraft Center. Other awards were received by Astronaut John H. Glenn, Vice Adm. William F. Raborn, Rocketdyne President Samuel K. Hoffman, Stanford University professor Howard Seifert, University of Minnesota professor John R. Winckler and Theodore Forrester of Electro-Optical Systems.

• If Thiokol Chemical Corp. wins the competition for the 260-in. solid motor, it is planning to build it in a new plant to be erected at Brunswick, Ga., by its Alpha Division. Land for the site has been optioned. It is on a waterway.

• Martin Co. has designed a six-man lifting body vehicle for space logistic support of manned and unmanned satellites and space stations. It would be launched by a recoverable booster in the *Titan III* or *Saturn* class. The SLV would be capable of landing on an aircraft runway.

• **Design revolution**—The aircraft designer's view that engineering changes are no more than the result of earlier errors must be abandoned by space system designers, an ARS panel was told. Continuous modification based on new design data must become part of the formal philosophy of space system design.

This was reported by P. E. Sandorff of Lockheed Missile and Space Co. in a paper on the need for design flexibility in space systems.

Sandorff said missions, environment, and component performance of space systems are seldom well defined at the beginning of a development program. Designs permitting easy modification late in the development cycle offer the best combination of reliability and efficiency at the cost of somewhat retarded delivery schedules.

The freeze-and-produce philosophy of aircraft development, under which engineering changes are regarded as an admission of guilt, compels the designer to make the "worst possible" assumptions about the circumstances of space flight in order to assure reliability; the result is unused excess capability—i.e., inefficiency—Sandorff said.

Design conditions expressed in orders of magnitude rather than in precise engineering terms, subsystems never evaluated in service, and frequent mission changes due to politico-economic considerations and other factors all contribute, Sandorff said, to uncertainty about what the end product will look like. Successful system designs progress naturally through a number of models, but as the size and cost of space projects increase it becomes necessary to obtain the reliability of the D model in the A version.

According to Sandorff, program management should be based on the recognition that:

—Engineering research and development is a continuing process rather than a phase in the program cycle.

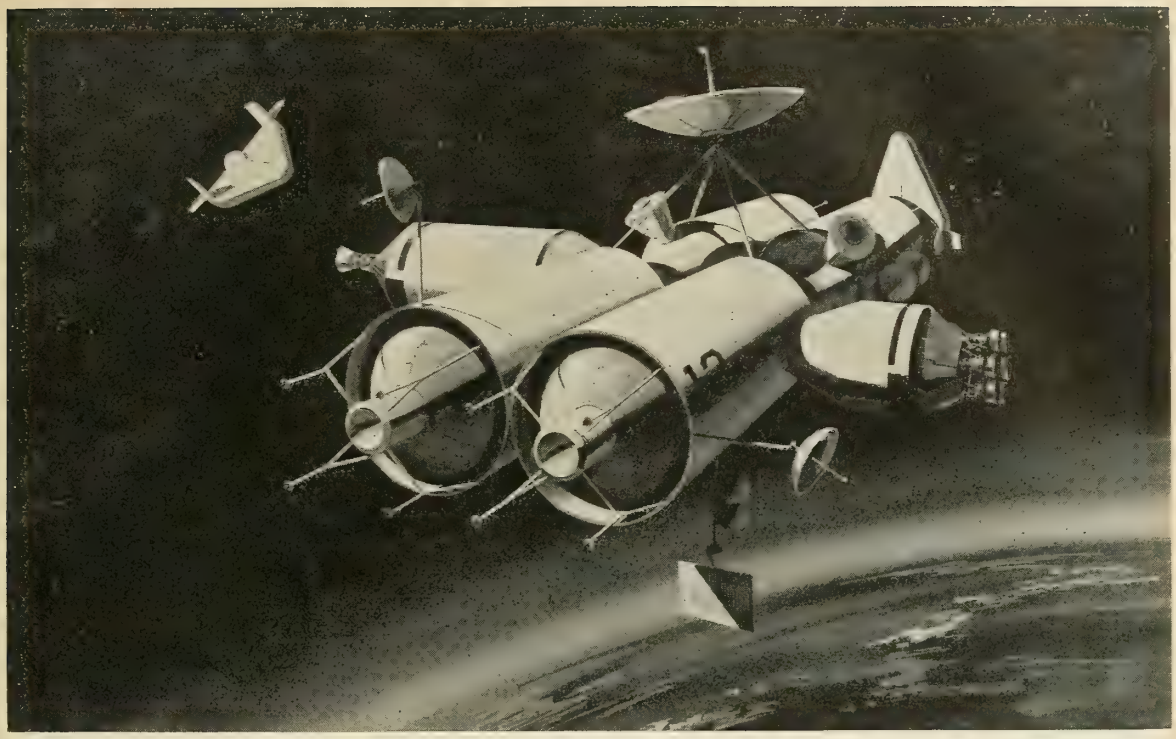
—Test programs are research. Collection of information about performance and the environment is more important than demonstrating that a specification is met.

—Engineering and manufacturing are the continuing development of each individual production item, rather than a succession of product improvement efforts applied to production lots.

• **Moon water**—Preliminary study of ways to extract oxygen and water from lunar rock were reported by Bruce B. Carr of the Callery Chemical Co.

He suggested a method of using a hydrogen arc jet, a water condenser and electrolysis to release oxygen from lunar rock to combine with the hydrogen stream forming water from which oxygen is electrolyzed. The method is not dependent on full knowledge of the Moon's composition, and Carr pointed out that, if the problem of lunar manufacturing is not approached until after detailed prospecting has been done, solutions could be long delayed.

The criterion for evaluating a lunar oxygen plant is pay-out time—the time required for it to produce a weight o



*THIS HUGE and versatile base could be established in Earth orbit before 1970, using existing technology and space vehicles already being developed, says Starr J. Colby, of Douglas Missile and Space Systems Division. Concept was outlined in ARS paper.*

oxygen equal to its own weight. It indicates how long the plant must operate to pay for its transportation to the Moon by eliminating resupply of oxygen from the Earth.

The most desirable raw material from which to obtain oxygen is water, and some studies indicate there is a possibility of finding it. However, it seems likely that surface deposits would be too small and scattered to be exploited. The suggested method of using a hydrogen arc jet and a condenser would be capable of collecting such free water but would not depend on its existence.

The plant would operate in a cavity in the lunar rock under a pressure of a few atmospheres. It would be capable of installing itself, since the arc jet could be used to dig the hole. With the top of the hole sealed off, the plant would function by melting silicon dioxide in a hydrogen stream at temperatures up to 2600°K. Chemical reaction between the two at high temperatures produces silicon and water. Maximum operating temperature must be less than the boiling point of the reaction product, silicon, because if it is vaporized it will recombine with the oxygen on cooling to become silicon dioxide again.

Water is condensed and frozen out of the circulating hydrogen at a temperature of −15°C. After electrolysis the oxygen has been captured and the hydrogen is recovered and recirculated back through the arc jet. The initial supply and replacement of losses will have to come from Earth.

If 5% of the rock is oxygen, a 20-ft. sphere of it should yield 44,000 lbs. of oxygen. The weight of a nuclear power supply and a plant capable of producing 5 lbs. of oxygen per hour is estimated at five to seven tons. If heavy metal oxides are encountered, the concentration of water in the hydrogen stream will vary, but design must be based on reduction of the silica. ⁂

## Aerojet Shows Its Pentad Injector

Los Angeles—Aerojet-General Corp. unveiled its variable-thrust five-orifice injector (M/R, Sept. 24, p. 43) at the ARS meeting here as a prospect for the Lunar Excursion Module storable-propellant propulsion system.

Configuration of the Pentad unit calls for five orifices which can be opened or closed simultaneously by use of five tapered pintles in the manner of needle valves. The amount of propellant flowing into the combustion chamber is controlled by adjustment through a mechanical linkage.

Aerojet said the unit displayed had been fired for 17 minutes at over 4000 lbs. peak thrust. The stainless steel needles showed little wear.

The method was said to offer 28.5-to-1 variability with a capability of going from full thrust to about 10% thrust in 0.05 sec. Range is from full to zero thrust. Aerojet now is engaged in scaling the unit up for the 8000-lb.-thrust LEM requirement and beyond.

Previous scaling had taken it from 100-lb. through 2000-lb. to 4000-lb.-thrust units.

The unit has been tested with storable propellant mixtures of nitrogen tetroxide and aerozine-50, inhibited red fuming nitric acid and UDMH, as well as with classified propellants.

Use of the five-orifice as against a multi-orifice system offers no difficulties in regard to stability, Aerojet asserted. A company spokesman reported that tests have shown stable combustion from high to low thrust, with stability increasing as thrust decreases.

The system was said to be applicable wherever high variability is required—as in LEM, Lunar Logistics Vehicle, and other soft-landing or rendezvous missions.

## *A 'foot in the door'. . .*

# Air Force Space Program Gains

### *NASA backing hinted if time and money problems force curtailment of space agency's Gemini project*

**by James Trainor**

AIR FORCE EFFORTS to gain a larger role in manned spaceflight appear to be winning grudging support from Defense Department officials—and a latent promise of backing from NASA.

Using a "foot-in-the-door," minimum-cost approach, the Air Force has proposed that it be allowed to buy four or five *Gemini* capsules with Fiscal Year 1964 funds. At the same time, NASA is re-examining the *Gemini* program to determine just how extensive a program it needs between *Mercury* and *Apollo*. There are indications that both time and money are likely to force curtailment of the *Gemini* effort originally set forth.

In this event, the space agency is expected to welcome suggestions by the Air Force that it be allowed to take over the program to explore spaceflight problems that NASA had to bypass. NASA officials do not rule out this possibility, but they refuse to commit themselves to expanded AF participation until they know the extent of their own *Gemini* program.

Biggest stumbling block for the Air Force is still DOD. However, the Defense Department is now reviewing the AF Space Plan—an outline of AF needs and requirements in space through 1970—in connection with the FY '64 budget. This review is expected to force upon DOD the realization that the only major building block missing in current space projects is a stable of experienced space pilots. Also, the cheapest, fastest way to develop a military competence in space is through *Gemini*.

As one hard-pushing AF official puts it, "we have to get into the program with next year's budget or events will have passed us by." In the time- and money-constrained *Gemini* program he sees a very real possibility of achieving this objective.

• **On to Apollo**—With the tight schedule imposed on NASA by the President to land a man on the moon within this decade—preferably sooner—space agency officials are going to be pretty well forced to terminate *Gemini* as soon as possible, an AF official says.

"You have to remember that *Apollo* is going to be on them pretty quick," he explains, "and (NASA Director of Manned Space Flight D. Brainerd) Holmes and his bunch are going to have to freeze on equipment and techniques early in *Gemini* in order to take care of *Apollo*."

Once NASA moves on to *Apollo*, it may make a lot of sense for the Air Force to pick up the program so that, when military missions for man in space are defined, "the building block called Man is not missing," he adds.

Two other reasons why AF officials feel that *Gemini* may be turned over to the military with full NASA support are money and further technical development.

NASA, Air Force officials say, is just beginning to realize the tremendous scope of the *Apollo* program as well as its tremendous cost. It is fast approaching the point where NASA will have to review all its programs and make conscious choices of which ones to develop—a position that DOD and most government agencies reached some time ago.

Right now, they point out, the *Gemini* program is being reviewed within NASA to determine whether the original program laid out is necessary or whether it could be cut back in order to save both time and money.

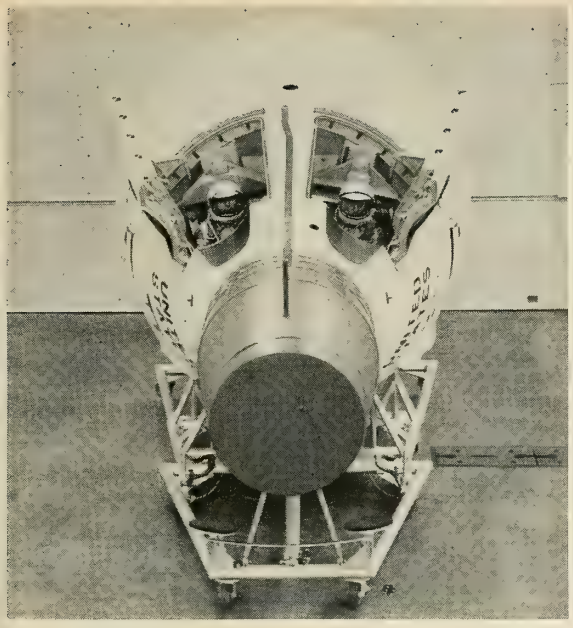
This review may well result in a reduced NASA *Gemini* program, with the Air Force taking up the slack and extending it beyond the presently scheduled 14 manned flights. Already, AF officials have submitted to Holmes informally a hypothetical plan to have the Air Force begin assuming control of the program about half way through the flight schedule.

• **Takeover plan**—Under this proposal, beginning with about the sixth manned flight, an AF pilot would occupy the co-pilot's seat and eventually both positions would be occupied by "blue-suiters." At the same time, the AF would begin assuming management functions for the *Gemini* program until eventually the entire management of the follow-on *Mercury* program passed to the Air Force.

Holmes rejected the plan on the basis that he could not, right now, commit himself to any definite date at which the AF could begin to take over the program. Reportedly, he was reluctant to discuss the issue until answers essential to the success of the *Apollo* program have been furnished by *Gemini*. Significant, however, is the fact that he did not reject the concept behind the Air Force proposal.

• **Sharing benefits**—Another reason for Air Force optimism over its role in *Gemini* stems from the fact that NASA will have to leave many potentially promising space techniques unexplored in order to fix as early as possible on *Apollo*. This means that NASA probably will be more than willing to have the Air Force—with its own money, of course—"tinker" with other, perhaps better, rendezvous and docking techniques or improved space equipment.

In addition, bioastronautics data gathered from 30-45-day flights in space which could be carried out by the Air Force would be welcomed by NASA, which would not have time to conduct such experiments itself. The capacity of a man to work outside a space capsule in flight will be explored by NASA, but only to the extent that it will support the *Apollo* program—



*HEAD-ON VIEW of Gemini capsule shows location of two astronauts. Air Force hopes to buy four or five of the McDonnell capsules.*

even then it will be a risky proposition since the entire capsule must be depressurized to allow a man to egress from the capsule.

The potentialities of space maintenance and repair can be explored and developed in the AF program more than would be possible under NASA's timetable. Also, peripheral scientific experiments could be carried out. All of this information, of course, could and would be fed into the *Apollo* space program.

Finally, the Air Force sees *Gemini* as a potential ferry vehicle for men and supplies to a *Manned Orbiting Development Station.*

All of these proposals are contingent on DOD approval. However, since R&D costs of *Gemini* development would be amortized in the NASA program, Air Force officials feel that the Defense Department would be receptive to buying, at a minimum, four or five *Gemini* capsules for military use.

Some Air Force officials favor this approach over a closely integrated NASA-AF program because it would represent a clean break with NASA and would not interfere with either agency's flight programs. A proposal to buy a limited number of *Gemini* capsules is in the FY '64 Air Force budget and is being reviewed by the Defense Department.

It is almost essential that the extent of Air Force participation in *Gemini* be defined in next year's budget because of the lead-time involved in capsule procurement. The lead-time reportedly is 14-15 months and, as one AF officer put it, "I doubt if McDonnell is going to want to deliver all its capsules in one year and then wait a year or more to deliver a second batch."

• **Present AF role**—Essentially, the Air Force is performing exactly the same mission which it performed for NASA in the *Mercury* program. It is responsible for the engineering, procurement and launch of the *Titan II Gemini* Launch Vehicle and the *Atlas-Agena* target vehicle, as well as for their injection into orbit. Both of these programs are handled through project offices at Space Systems Division in California.

However, last May, in recognition of the probable increased AF effort in the *Apollo* program, the position of Deputy Commander for Manned Space Flight was established at Air Force Systems Command headquarters. Headed by Maj. Gen. O. J. Ritland, the office provides an interface with NASA's Office of Manned Space Flight while concurrently maintaining cognizance over military space programs and other NASA projects.

At present, approximately 28 military personnel are assigned to Gen. Ritland, representing almost the entire complement of the 31 authorized. The organization is divided into two major segments under a Deputy Director for Space Programs and a Deputy Director for Space Support.

The former—headed by Col. C. G. Mathison—has a task much broader than just supporting the *Apollo* program. It also provides support for NASA's space sciences programs such as *Mariner* and *OGO*. Although this support is primarily restricted to boosters, the office provides such things as range instrumentation services and on-orbit control of NASA satellites.

Under Col. H. W. C. Shelton, the Space Support Office consists of six or seven highly qualified officers physically located with D. Brainerd Holmes' Office of Manned Space Flight. Each of these officers works directly with one of the six directors under Holmes. For example, NASA's director of Spacecraft and Flight Missions, George Low, has Col. Don Heaton following his programs while Col. J. Talbot works closely with Charles Roadman in Aerospace Medicine, as well as other NASA and DOD organizations.

Shelton's office is not expected to grow significantly. AFSC Gen. B. A. Schriever wishes to limit its size and, in the document approving the setup, DOD specified that it would be kept small.

In explaining the setup, an AF officer assigned to the office says "in a very real sense we don't do anything down here; details are handled by Mathison's office." The primary purpose of the office is to make suggestions on how the Air Force can help the manned spaceflight effort and to make recommendations on, and trouble-shoot, specific problems. In addition, Shelton and his staff try to keep themselves informed of NASA progress and in turn keep the rest of the Air Force informed.

However, they are careful not to get in the way of what Shelton describes as "a pretty fast-moving, dynamic organization." There is no fiat requiring NASA to invite AF participation in planning sessions and meetings, he points out, but a good working relationship is building up and the personal and professional relationships between NASA and his office are excellent.

One area of growth in this relationship would be to extend the scope of the Space Support office to cover other areas of NASA such as Space Sciences and Advanced Research and Technology. As it stands now, the office is accredited only to Holmes, though some contacts with other NASA offices have been made on an informal basis.

Over and above the formal organization, however, are weekly informal meetings between Ritland and Holmes to discuss various problems. Ritland also has attended many meetings, briefings, reviews and proposal presentations at NASA's invitation. He attends NASA's "black Saturdays" in which Holmes, NASA Administrator James Webb, Associate Administrator Robert Seamans and Deputy Administrator Hugh Dryden thresh out problems in the Manned Lunar Landing Program. However, since he has no responsibility for the program, Ritland does not get involved in internal management problems. ⌘

*Election aftermath . . .*

# Few Space Committee Changes in Congress

by Frank G. McGuire

FEW MAJOR CHANGES as a result of the Nov. 6 elections are expected in the Congressional committees that directly affect the missile/space industry. Two Republicans and four Democrats are leaving the House Space Committee, and two Republicans on the Senate Space Committee lost re-election bids.

Sen. Robert S. Kerr and Rep. George P. Miller, chairmen of the two space committees, both remain through the 88th Congress. Kerr was not running; Miller won re-election.

The GOP lost two long-standing senators, Alexander Wiley (R-Wis.) and Homer E. Capehart (R-Ind.) from the Senate Space Committee. No Democratic members of the committee lost.

• **The House**—On the House Space Committee, the Democrats will lose four members: Reps. Walter H. Moeller, (D-Ohio), defeated; David S. King (D-Utah), defeated for Senate; Victor L. Anfuso (D-N.Y.), redistricted out of a seat; and Corinne Riley (D-S.C.), retired. Republicans leaving the House Space Committee are Jessica M. Weis (R-N.Y.), retired, and Perkins Bass (R-N.H.), defeated for Senate.

New committee members appointed by the two parties will rank low in seniority and thus exert little influence in the work of the committees.

With the defeat of Sen. Wiley, the Senate Space Committee loses its ranking GOP member. Next in line for the spot is Sen. Margaret Chase Smith (R-Maine). (The ranking member of the opposition party is the "shadow chairman" of the committee, who takes over leadership if control of Congress passes from one party to the other.)

Whether the standing of the GOP committee members will remain as it currently is has not yet been decided. Sen. Smith may move to another committee assignment if much shuffling is done by the GOP.

Wiley, a member of the committee since its formation in February 1958, became ranking GOP member upon the death of Sen. Styles Bridges. Sen. Capehart, a member of the committee only since the beginning of this year, was the GOP replacement for Bridges.

• **Big solids hurt**—On the House side, the loss of Rep. King will be felt by advocates of large solid rockets, inasmuch as he was one of the strongest voices favoring large solid boosters. Rep. Emilio Q. Daddario (D-Conn.) will take over the fourth subcommittee—Applications—now that Rep. Anfuso is gone. Daddario was formerly chairman of a special patent subcommittee and instrumental in NASA's changing of its patent policies.

Subcommittees of the House Space Committee formerly identified by number are now organized along lines similar to NASA—by subject matter. This has raised a problem in that Congressmen moving up in seniority are faced with either learning a completely new branch of space science as they change from one subcommittee to another bearing more prestige, or staying with their own cultivated field of specialization and sacrificing the increased prestige.

The most prestigious subcommittee currently is that on manned spaceflight, chaired by ranking member Olin E. Teague (D-Tex.), and followed by the Space Sciences subcommittee of Rep. Joseph E. Karth (D-Minn.); the third subcommittee, that on advanced research, is chaired by Rep. Ken Hechler (D-W.Va.).

The four subcommittees are expected to carry considerable influence during this Congress, primarily due to the policy of Committee Chairman George P. Miller, who feels the subcommittee chairmen should have ample freedom of action to make their subcommittee effective. Result of this is partly seen in the reorganization of the *Centaur* program after the 87th Congress hearings held by Rep. Karth's subcommittee.

The House Space Committee, far more active than its Senate counterpart, would react favorably to a NASA supplemental budget request early next year, but committee staffers do not feel such a request is likely. Earliest item on the committee's agenda is the NASA authorization bill, on which the four subcommittees held simultaneous hearings for several weeks last year while the Senate Space Committee held three days of hearings.

A Senate committee spokesman said, however, that holding hearings is not a prime objective of that body.

House hearings on NASA's authorization are expected to last as long as they did this year. ¤

## Big Solid Spending May Quadruple

NASA-DOD AGREEMENT on a large solids development program is expected to result in an FY '64 spending level of $100 million—almost four times the $28-35 million to be spent this fiscal year.

In addition the two agencies have agreed to by-pass development and testing of the 156-in.-class motors and go directly to the 260-in. motors. This would put the large solid motors in a competitive position for the *Nova* booster, which is not likely to begin development before 1966.

The agreement was reached in a meeting of Secretary of Defense Robert S. McNamara with NASA Administrator James E. Webb approximately 10 days ago.

Requests for proposals are expected to be issued by the Air Force within a couple of weeks for advanced development work on critical areas of booster technology. Subjects to be investigated include nozzles, thrust vector control and mating of segments to preclude leakage. More than one RFP may be issued, with one covering the advanced technology and the other the building and testing of segments.

Decision to skip the 156-in. program was made because it was not a big enough step from the 120-in. motor technology of the *Titan III*. The feeling was that this size motor could be built any time with facilities and technology already available.

Management of the large solids program is to be by the Air Force Systems Command's Space Systems Division, with actual supervision of the program being handled at Edwards AFB, Calif.



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# Technical Countdown

## ELECTRONICS

### 'Hot Window' Effect All But Eliminated

Recent measurement techniques indicate Eastman Kodak's Irtran materials will practically eliminate "hot window" effects in infrared guided missiles. The effect is a secondary one produced by the aerodynamic heating caused by the missile's passage through the atmosphere. The Irtran materials—polycrystalline substances formed by heat and pressure into solids of near theoretical density—emit very little radiation in the infrared wavelength region even when heated to more than 1000° F.

### Holloman Tests Improved Circuits

A NASA-developed circuit connector designed to overcome the problem of faulty electrical plugs has been tested at Air Force Systems Command's Missile Development Center, Holloman AFB, N.M. In a series of six rocket sled runs to simulate missile launch conditions, the connectors withstood higher than normal takeoff and re-entry vibrations without "breaking a circuit."

### Army Automates Missile Parts Catalog

A rapid retrieval system, called VSMF, will be in use by the Army Missile Command at Huntsville, Ala. next January to catalog common-use Army missile system parts for rapid use. Developed by Information Handling Services, Denver, Colo., the system groups photographs of components and their specifications on cartridges of microfilm. The film can then be sent to Army missile contractors and subcontractors to assist designers and engineers in selecting components for Army missiles.

### Fuel Cell Tested in Zero G

An Allis-Chalmers fuel cell being developed for both the Air Force and NASA was successfully tested under simulated zero-g conditions at Wright-Patterson AFB, Ohio. Using a modified KC-135A flying a zero-g trajectory, the hydrogen-oxygen fuel cell produced electricity for 32 seconds under conditions similar to those experienced by an orbiting satellite.

### Apollo Battery Contract to Eagle-Picher

Electric power during and after the re-entry portions of the *Apollo* flight regime will be supplied by batteries from the Eagle-Picher Co. Two of the three units will go into operation at the service module separation. The third battery, with a life span of three days, functions after landing and will operate the *Apollo* life-support system and recovery equipment until pickup.

## ASTRONAUTICS

### Solar Flares Predictable 35 Days in Advance

A "space weather" observation technique using an improved statistical method developed to search for distinctive characteristics of solar activity permits the prediction of solar events as much as 35 days in advance with 70% accuracy. North American's Space and Information Division experts are now working on the false alarm rate. The ability to make such long-range predictions as against the present three-day warning method may reduce or even eliminate shielding requirements for protection against emission of energetic protons from the sun.

## MATERIALS

### Second-Generation Moly Alloy Perfected

A molybdenum-base alloy with about 0.5% titanium and 0.8% zirconium, equivalent on a strength-to-weight basis to commercially pure tungsten at 2600° to 3000°F, is being produced by Climax Molybdenum Co. Dubbed "Climelt TZM," the alloy can be fabricated into any desired part and is available as forging billets, bars, rods, sheets and plates. The alloy will probably be used on high-temperature portions of the *X-20 (Dyna-Soar)* leading edges after being coated with moly disilicide. High temperature fasteners have also been produced from TZM.

### Titanium Alloys Usable to −452° F

Army metallurgists report most titanium and nearly all aluminum alloys are acceptable for cryogenic applications. Low-temperature mechanical properties of both alloy systems were obtained at the Watertown Arsenal in bar and sheet form as a function of testing temperature. Tensile and impact properties in bar materials were studied down to −452°F, and sheets were submitted to −320°F to get tension data. Notch tensile ratios for sheets provided a criterion for resistance to brittle fracture.

### 4000° F Vacuum Insulation Released

A spacecraft vacuum insulation system using ADL-17, graphite fibers and thoria powder in combination with a tantalum radiation shield can handle temperatures higher than 3000°F for more than 100 hrs. A research report from Arthur D. Little, Inc. just made available by OTS, recommends future work in materials research, insulation system development and thermal conductivity measuring techniques. If tantalum foil is to be used as an insulation component, ADL experts suggest the reaction between the metal and graphite be investigated more thoroughly to determine if surface treatment of either could reduce the reaction rate.

### Beryl Crystal-Growing Process Revealed

A new method for rapidly growing large beryl single crystals has been developed by Bell Telephone Lab researchers. Such crystals, when doped with chromium impurities, may find use in high-frequency microwave masers. The process involves placing dehydrated beryl on the bottom of a platinum crucible covered with small amounts of berylium oxide, ammonium-chromium-sulfate and then filling with vanadium-pentoxide. The crucible is so heated to have the bottom reach 1050°C and the top 1000°C. The beryl in the bottom dissolves and crystallizes out on a seed plate slung in the lower temperature region of the solution.

### Goodyear Builds Arc-Tunnel

An arc-heated wind tunnel designed to simulate re-entry and supersonic heat is in operation at Goodyear Aircraft Corp. The $250,000 facility will be used for studies into areas of flow visualization, heat flux measurement, pressure distribution, material evaluation and gas distribution. An auxiliary magnet that causes the arc to rotate at high velocity is included in the unit. The magnetic field allows a wide range of simulated flight conditions, and use of both a continuous vacuum and a d-c power source permits operating periods up to a maximum of 20 min.

# Lear Siegler Aims to Double Sales

## *Increased government systems business is included in firm's push toward $500 million in five years*

by Willard E. Wilks

LOS ANGELES—Lear Siegler, Inc., the $200 million offspring of a five-month-old merger between Lear, Inc., and Siegler Corp. has set out to more than double sales—aiming at $500 million in five years.

To Board Chairman John G. Brooks, this objective seems conservative. Brooks, with a group of investors, bought Siegler Heating Co., Centralia, Ill., in 1953 and pushed it from sales of $6.5 million to $100 million in the eight years before the merger.

The corporation is seeking to achieve its new goal through two prime efforts: by obtaining more large government systems business, and by raising the proportion of consumer and industrial business to 60% of total sales. The latter move would reverse its present 60-40 defense-commercial ratio and get back to the split Siegler had before the merger with Lear (which was 90% defense).

"This does not mean that we will not continue every effort to get every piece of government business we can get," Brooks told M/R.

LSI is taking steps to make use of multi-divisional capabilities, particularly on the defense side of the corporation's business.

"We think this is the way to get more heavily into large government systems," Corporate Senior VP John J. Burke says. "Otherwise the programs we take on are limited to the capabilities of a single division.

"Tasks in the (Siegler) past have generally been the undertaking of one division. An exception was the job of designing and producing the launch control equipment for *Atlas-F* sites. This will be wound up within a year and will be worth about $30 million when completed. It has involved the effort of four divisions and is an example of the type of government program we want to shoot for. . . ."

• **Division management problem**—Big problem in setting up for a multi-division effort is management, Burke said, noting that "all of the services have been badly burned on the problem of dealing with multi-division companies."

Corporate VP Dan W. Burns put it this way: "Multi-division companies all are faced with this problem: How do you allow your divisions to have the management responsibility and stimulation they must have to pursue their own markets and grow as entities, but at the same time provide the mechanism for bringing together all their talents to take on a job that is bigger than any single division?

"This situation is unique because at this time the industry has not yet evolved a management practice for handling this problem. The only thing you see on the wall is negative—you see only what didn't work. Our answer is our newly-organized Defense Systems Operations, an organization at the corporate level that functions both staff and line, that provides systems management, systems engineering and technical direction and contract and financial management."

The Defense Systems Operations organization was devised solely to seek and deal with multi-division efforts, with no attempt made to pull in present division efforts. With prime interests in tracking and control systems, communication and data systems, range instrumentation and support systems, instrumented satellite and space probes, and tactical weapon systems, DSO is designed to draw upon the capabilities of LSI's seven defense divisions.

• **Organization breakdown**—These are Astronics, Santa Monica, Calif.; Astro Structures, El Segundo, Calif.; Data & Controls, Long Island, N.Y.; Instrument division, Grand Rapids, Mich.; Electronic Instrumentation, Anaheim, Calif., Power Equipment, Maple Heights, O.; and Lear Siegler Service division, Grand Rapids.

Burns is head of DSO, with his organization boxed directly off corporate headquarters on LSI's organization chart. As initiator, organizer and director of multi-division efforts, it consists of three operating units, including Space Systems Center, Defense Systems Office, and one or more Systems Managers.

Nucleus of Space Systems Center is a group acquired from Space Technology Laboratories. The former STL group, which was responsible for range instrumentation and range safety in the ICBM program, simply moved as a unit to Siegler in November 1960.

Burns gave this rundown on his organization: "Space Systems Center has two functions. It has a profit and loss



*LSI CHAIRMAN J. G. Brooks (left) and Corporate President A. D. Handschumacher.*

function, providing study analysis for various parts of Department of Defense and NASA. This is purely analytical study, tending to fall in range safety analysis, range instrumentation study and mission assurance analysis.

"The center's other role is to provide systems analysis and systems engineering and technical direction for LSI multi-division operational undertakings. Defense Systems Office is responsible for plans and objectives, customer requirements and regional liaison.

"The system manager is responsible for the actual line management of a multi-division program. He manages the SETD function and is responsible to both the customer and the corporation for overall financial management of the task."

• **Future program planning** — LSI has a management plan model ready for use when it acquires a multi-division program.

"We take a system manager out of Defense Systems Operations and give him overall responsibility," Burns said. "Then all of the divisions involved report line to him rather than to the corporate staff. And we pick a lead division, usually the one which has the most business involved in the task. The lead division has responsibility for systems integration, assembly and checkout."

In setting up Defense Systems Operations, LSI followed the streamlined management philosophy that Brooks believes has been responsible for Siegler success to date. "We have only five men at the top in the corporation," Brooks says. "Any one of them is capable of making a decision at any time in event I am out of town. We can do this because our communication is so good."

Brooks is convinced there is too much "accumulation of fat at the corporate level" in most large organizations.

Brooks uses this rule-of-thumb in determining whether he needs a corporate level executive: "If that person was not there would you lose any money?"

As for experts such as legal counsel and management consultants, Brooks' philosophy is "that if we need them we can hire them from outside."

• **The top five**—LSI's top men in corporate, in addition to Brooks, are President Albert G. Handschumacher, former president of Lear; Executive VP Robert L. Purcell, Senior VP-Secretary Robert T. Campion, and Burke. The corporate staff of LSI, which currently employs 10,000 persons, totals 19, including secretaries. "We have no staff of second-guessers," Burke says.

Brooks' emphasis on streamlined management at the top demands strong management at the division level. In the firm's planning activities, he says, "we don't set ourselves up in the corporate office as the almighty seers. We use our technical staff, or division heads who are on the firing line."

• **Research expansion**—Dr. Jay Tol Thomas, director of central research, which reports to corporate headquarters, plans to expand his present staff of 64 to 170 technical and 130 support personnel in the next 30 months. Thomas visited all operating divisions earlier this year and came up with five areas "in which I think we should invest over the next few years." The areas include microcircuitry, using thin-film techniques, automatic control, information sciences, medical physics and low-temperature physics.

In the field of automatic control, Thomas points out that seven or eight years ago Lear had a major portion of the autopilot business "but with the esoteric developments of the past few years, neither Lear nor Siegler kept up with the field. Litton and Minneapolis-Honeywell have moved ahead of us. We are going to catch up."

In the information sciences area, LSI has radar and communications experience, but according to Thomas "no core of people to produce anything in the analytical line." In a related area, LSI is writing a proposal for a system to prevent jamming of information-gathering satellites.

• **Medical physics goal** — Thomas sees good possibilities for growth in the medical physics field and recently acquired three doctors with experience in electronics.

"We plan to use this medical-electronic mixture for space systems, as one of our heretofore missing links in bidding on space projects," Thomas says.

A future LSI item for manned space vehicles might be a system that would process EKG and EEG information aboard the spacecraft and send only yes-no type information to the ground rather than detailed data, enabling use of narrow band.

In the low-temperature physics area, LSI will direct effort into superconductivity of thin films. It has a $50,000 research contract to investigate use of thin film as an inertial grade transducer.

Thomas is looking at the possibility of using superconductivity in storage registers and switching elements. "We have the low-temperature know-how and thin-film know-how to get into microminiaturized solid-state special-purpose computers," he says. "We won't compete with IBM and the rest. In other words, we're not going into commercial computers."

Thomas adds that LSI's research effort is now about 60% company-funded and he will seek more outside support.

• **Current contracts**—LSI currently has between 500 and 600 contracts in



*CORPORATE Vice President D. W. Burns.*

force, and a backlog of about $100 million, considered a good figure for a company without large government contracts with long lead times.

Largest single contract is the one from General Dynamics/Astronautics for *Atlas* automatic launch-control systems.

Others totaling about $42 million so far, include $2.2 million from Air Force Systems Command for meteorological radar sets; $1 million from Sperry Utah for *Sergeant* control surface actuators, and an undisclosed sum from McDonnell Aircraft for flight attitude and delta velocity indicators for *Gemini.*

As an outgrowth of its consumer radio and television experience, the company has developed highly specialized TV cameras and complete video systems for military and space installations. It is providing the TV camera for viewing *Centaur* fuel in the zero-g environment during flight tests.

• **Missile-related work** — LSI has developed a three-axis flight director-attitude indicator for *X-20,* and produces spin-forged cases and other components for *Titan, Minuteman, Saturn, Able-Star* and *Tartar.*

Other business encompasses communications equipment, including ground-recording and monitoring equipment for *Surveyor;* ground-support equipment for *Sergeant, Discoverer, Minuteman, Polaris, Titan,* and *Saturn.*

LSI's recent proposals include one to manufacture the static-test and data-collection systems associated with the *Saturn* and *Nova* projects at Cape Canaveral, Huntsville and Pearl River, Miss. It recently completed systems design under a prime NASA contract.

The firm feels its past record, involving some contribution to nearly every major rocket program and its *Atlas* launch equipment work should put it in a position for more launch control and checkout business in the next few years. It also expects to be active in advanced communications, currently holding a NASA contract for design of a deep space probe communication system. ⁘

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# UTC DEVELOPMENT
# THRUST OVER

**STATE-OF-THE-ART ADVANCEMENT**—United Technology Corporation takes pride in announcing what may be one of the most important liquid rocket propulsion technology developments in this decade: variable thrust control over a range of 1-to-100. This company-sponsored development can provide upper stage liquid rocket motors with the levels of operational flexibility demanded for rendezvous, docking, and soft landing missions. UTC's new aerated-thrust motor will permit a spacecraft to hover, translate, and re-orientate with a maximum degree of precision and control.

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# CONTROLS

# 1-TO-100 RANGE!

**IPROVED MOTOR PERFORMANCE**—Hot firing sts of this UTC propulsion device indicate at motor efficiency is improved to 95% of eoretical $I_{sp}$. Motor life is prolonged, since e aeration technique prevents unbalanced mbustion, channeling, and erosion of thrust amber walls. The possibility of explosion ring motor firing is almost completely elim-ated. The safety, reliability, and flexibility UTC's new system of variable thrust con-l by aeration make it a strong candidate r use in lunar excursion missions, orbital vision, or module-to-mother-ship docking.




**United Technology Corporation**

Box 358, Sunnyvale, California

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# Astronauts' Star Recognition Training Intensifies

***Carl Zeiss projector instrumental in aiding instruction in vehicle attitude, navigation and research observation***

**by Paul Goerz Langfeld**
*President, Carl Zeiss, Inc., New York*

CELESTIAL RECOGNITION training may become a virtual prerequisite for manned space flight.

Astronauts John H. Glenn, M. Scott Carpenter and Walter M. Schirra attended specially designed courses at the Morehead Planetarium of the University of North Carolina at Chapel Hill, where a massive Carl Zeiss Planetarium Projector and a Link trainer were modified and programed to teach navigational orientation by the stars.

Now all seven original *Mercury* program astronauts have attended periodic intensive courses using the Zeiss equipment, and new astronauts picked for the *Gemini* program are expected to follow suit.

Though instruction in celestial recognition collectively occupied only a few days of the astronauts' overall training, it constitutes an important part of spaceflight preparation. Three of the in-flight tasks assigned for orbital flight—vehicle attitude, navigation, and research observation—are related to celestial navigation.

In sessions with the Carl Zeiss projector at the planetarium, astronauts learned to identify the constellations and major stars as seen through the viewport of a space capsule. With a simulated space vehicle—a modified Link trainer—they practiced correction for orientation in relation to these stars. And they were briefed on unusual astronomical phenomena that might be encountered during flight.

• **Program objectives** — Morehead Planetarium's celestial recognition training program, begun in 1960 and still in progress, has several goals. One of these is to give an astronaut a simple means of estimating his location and orientation with respect to Earth when his view of Earth is obscured and he does not have use of instruments.

This information, of course, becomes particularly important in case of emergency re-entry necessitated by control system failures or inability of the astronaut to continue.

At the planetarium, the astronauts learned under simulated flight conditions to line up known star patterns with a grid scribed on a capsule viewport to obtain the navigational information desired. This system was among those used later in actual spaceflight.

On future missions, astronauts may also use stellar recognition information to calibrate navigation instruments during orbital or interplanetary flights.

Another major objective of the Morehead course is to help prepare astronauts for scientific observations during flight by familiarizing them with the celestial map.

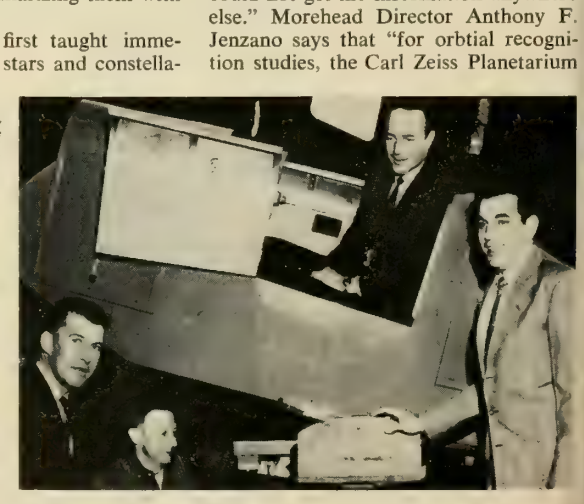
Astronauts are first taught immediate recognition of stars and constellations while the full sky is visible, projected by the Carl Zeiss instrument. Then a simulated capsule viewport is introduced, obscuring all but small portions of sky as they would be seen in flight.

The astronauts are taught to distinguish as normal or unusual any celestial objects or phenomena. In actual spaceflight, they would relay such information back to Earth for further examination by scientists with radio and optical telescopes.

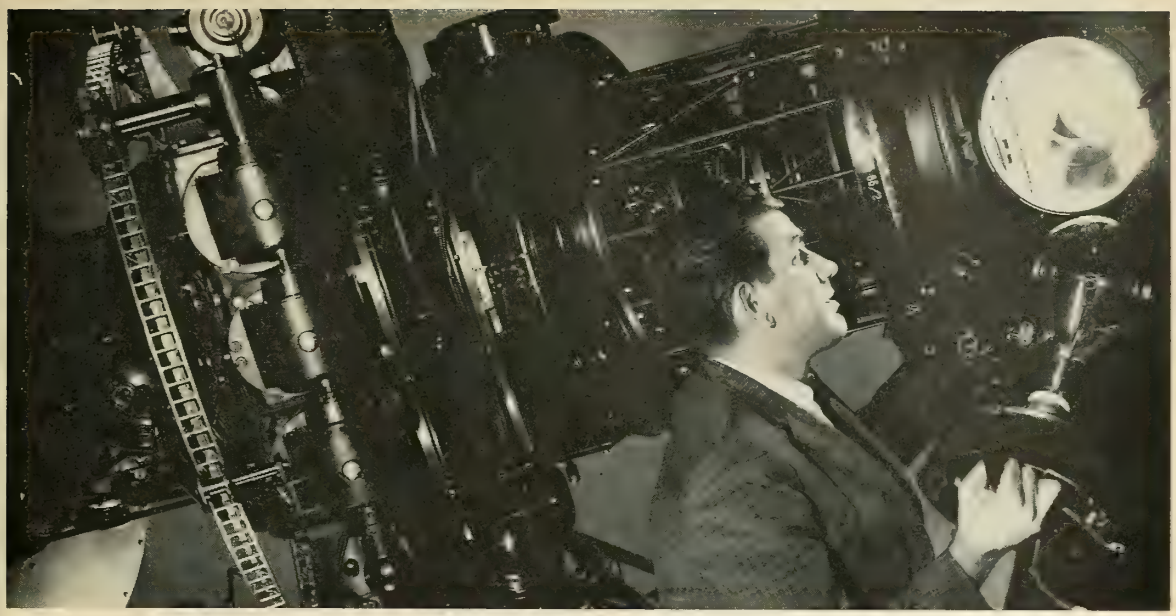
• **Morehead ideal**—The Morehead Planetarium was selected for this program because it offers, with its Carl Zeiss Planetarium Projector, the most effective equipment for highly condensed and accurate astronomical instruction.

Astronaut Glenn said in 1960 that Morehead "was selected for this phase of the training because it had the highest qualifications of any available, and we could not get the information anywhere else." Morehead Director Anthony F. Jenzano says that "for orbtial recognition studies, the Carl Zeiss Planetarium

Photos courtesy University of North Carolina photo laboratory.



*LINK TRAINER being examined by Scott Carpenter (in trainer), and Walter Schirra (far left). Morehead Planetarium Head Technician John Brittain adjusts trainer and Planetarium Director A. F. Jenzano is at far right.*



*STAR LAMPS illuminate Carl Zeiss instrument's 32 composite projectors in its two large spheres.*

instrument proves to be an invaluable asset. Remarks to this effect were expressed by the astronauts throughout these sessions."

Jenzano said two requests made by astronaut Walter Schirra immediately prior to his orbital flight were for "an added session in the centrifuge, and an added session on celestial recognition at Morehead."

Several government agencies with missile/space activities have asked Jenzano whether staff members other than the astronauts might receive the same training. Jenzano said the planetarium also welcomes missile/space industry queries regarding other possible applications for the instruction and the equipment used.

• **Preparation** — The astronauts were scheduled for instruction in pairs. Four planetarium sessions—two to three hours each with interspersed breaks—were scheduled for each pair.

The astronauts previously had been assigned to study the names, chronology and first- and second-magnitude stars of the constellations of the Zodiac—starting with Aries, Taurus and Gemini, and continuing chronologically through Capricornus, Aquarius and Pisces.

"The belt of the Zodiac is 18 degrees wide, with the ecliptic as its central line; and the 12 Zodiacal constellations each comprise an area 30 degrees wide on this belt," Jenzano points out. "With this chronology and the astronaut's normal attitude, these constellations will appear first at the top of his port and continue to descend diagonally."

• **The first day** — Instruction of each pair of astronauts began with exercises in rapid identification of the Zodiacal constellations and location of the Sun, Moon and planets within these constellations. They had a full view of the projected heavens at this time, with the celestial sphere moving at its slowest rate—360 degrees in 10.5 min.

In the first afternoon session, the astronauts practiced recognition of additional stars and constellations adjacent to the Zodiac—primarily those between latitudes 35 and 50 degrees, north and south of the equator. At their hotel in the evening, they memorized stellar latitudes and reviewed and tested each other on constellation chronology and constituent brightest stars.

Instructional material included star maps, celestial-terrestrial globes and reference texts on objects and areas on and adjacent to the proposed orbital flight path.

• **Inside the "capsule"** — On the second day of instruction the astronauts received their first training inside the simulated space capsule with a strictly limited field of view. A standard Link trainer was modified with controls and driving mechanism to yaw like an actual space vehicle, and fitted with a simulated viewport.

Recognition now became more difficult, as only a few stars of each constellation were visible. The celestial sphere was still moved at the rate of 360 degrees in 10.5 min., while a yaw of up to 60 degrees was introduced.

The planetarium projector was stopped for discussion whenever necessary during this and following sessions.

Each pair of astronauts worked as a team on this part of the instruction—one would introduce excessive and erroneous yaw, while the other, inside the simulator, corrected it with reference to the stars.

During this session, the celestial sphere was moved in accordance with an anticipated equatorial flight pattern supplied by NASA. In addition, the astronauts periodically correlated stars with substellar latitudes on Earth. The planetarium coordinate lines of the meridian and the equator served as aids in identifying these latitudes, and a celestial-terrestrial globe also was used.

Early in the session, a green line was projected through the planetarium sky to indicate the orbital path that the astronauts were to maintain in the view of the simulated capsule. Later, the green line was extinguished, and orbital paths were followed by the stars alone.

• **Follow-up training** — Just prior to orbital flight, the astronauts received two more days of follow-up training at Morehead Planetarium. This consisted of "celestial programing"—recognition drill—along specific anticipated flight orbits.

Alternate celestial paths consistent with possible launch delay times were also studied. For astronaut John Glenn this additional drill turned out to be well advised: Glenn's actual orbit differed from the originally anticipated path because of launch-time slippage.

In these follow-up sessions, the viewport of Link trainer "capsule" was simulated by another, more portable viewing device.

In a space capsule, the astronaut looks simultaneously through two windows with different shapes and angular placements. His vision area is resolved into a shape somewhat different from either of the two windows.



*PROJECTOR uses 32 precision starfield plates to show celestial patterns.*

To simulate this effect, Jenzano devised and constructed a special device that limits angular vision to that of the exact capsule viewport and that can be conveniently and expediently used independently by each astronaut.

Carpenter and Schirra took similar follow-up courses in anticipation of their orbital flights on May 24 and Oct. 3.

• **Adapting the planetarium**—Jenzano and Morehead's Head Technician John Brittain specially adapted the Carl Zeiss Planetarium Projector for the astronaut training program. During the program they added—and integrated with the instrument—two special adjustable projectors to superimpose over the planetarium stars green lines indicating orbital flight lanes. With these devices, Jenzano said, any equatorial orbital path—for any launch time and date—can be projected.

Two 1000-hr.-life, 1000-watt star lamps in the instrument's two large spheres illuminate 32 composite projectors, each showing a portion of the sky. One sphere projects the southern half of the sky, the other the northern half.

The 32 starfield plates are made of copper foil slightly more than .0005 in. thick sandwiched between thin cover glasses and punched with 65 different-sized holes—ranging from .001 in. to 1/32-in. dia.—to indicate different degrees of star brightness.

The brightest star — Sirius — and three typical variable stars—Mira Ceti, Algol in Perseus and Delta Cephei—are produced by separate variable star projectors. Two special cylindrical projectors show a photographed reproduction of the Milky Way.

Automatic occulting devices dim and finally black out the stars as they approach the horizon. Special optical zoom devices simulate visual effects that would be experienced in transit.

• **Projector capabilities** — Driven on its three axes by seven motors, the Carl Zeiss Planetarium Projector at Morehead can demonstrate the normal apparent movements of the sky over a simulated 24-hr. period at several speeds.

The instrument can show the heavens from all latitudes in approximately 2.5 min. and display the complete processional cycle—during which the celestial poles of the Earth describe a complete circle and demonstrate a cycle of 25,800 years in 1.25 min.

Shortly before the beginning of the astronauts' celestial recognition training program in 1960, Morehead Planetarium's technical staff headed by Brittain completely disassembled, refurbished and re-assembeld the projector. They installed special collars on each of the large projection spheres to show more realistically and accurately the 42 brightest stars of the first and second magnitude. The collars are a post-war development by Carl Zeiss, Inc., whose scientist Dr. Walter Bauersfield invented the projection planetarium in 1919.

The Morehead overhaul was the first of its kind ever performed in the Western Hemisphere without the guidance of a technician from Carl Zeiss headquarters in West Germany.

• **Future prospects**—The astronaut training program at Morehead is still in its early stages, Jenzano believes, and each of the major objectives has been only partly achieved.

Jenzano expects celestial recognition training to be stepped up as space exploration advances. "Considerable additional practice and study will be required for the astronauts to attain *spontaneous* recognition and evaluation ability," he points out.

More frequent study sessions will be required in later phases, and new needs will undoubtedly be revealed as overall training proceeds, Jenzano predicts.

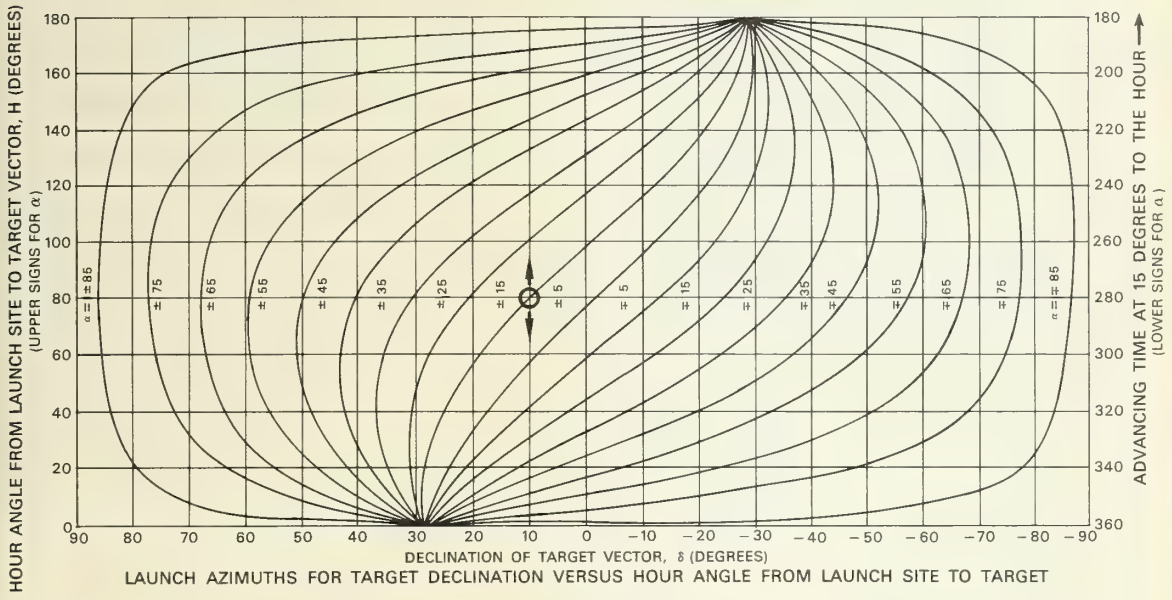
Future space recognition training at Morehead is expected to play an increasingly important role in space navigation. Knowing the substellar latitude of given stars and calculating the time he has been in orbit, the astronaut has two vector components with which he can resolve his approximate position over Earth.

According to Jenzano, "by knowing the stellar latitude (celestial declination) and longitude (celestial right ascension) of enough first- and second-magnitude stars, and having the ability to recognize these stars by stellar association, astronauts conceivably can follow pre-established 'celestial skyways' through any given orbit or space trip."

If several of these stars are on or near the orbital latitude, Jenzano says, they would provide "guidance points" apparently moving along or near a scribed line on the astronaut's viewport. For any given orbit, specific stars would be selected in advance to establish the celestial or orbital lane.

"As space travel develops," Jenzano predicts, "this system is certain to pioneer or reinforce elaborate instrument systems: for practical purposes, the stars will prevail as visible and fixed points of reference, with only a minor consideration of stellar parallax." ⁂

# LUNAR LAUNCH · JULY 17, 1968




LAUNCH AZIMUTHS FOR TARGET DECLINATION VERSUS HOUR ANGLE FROM LAUNCH SITE TO TARGET

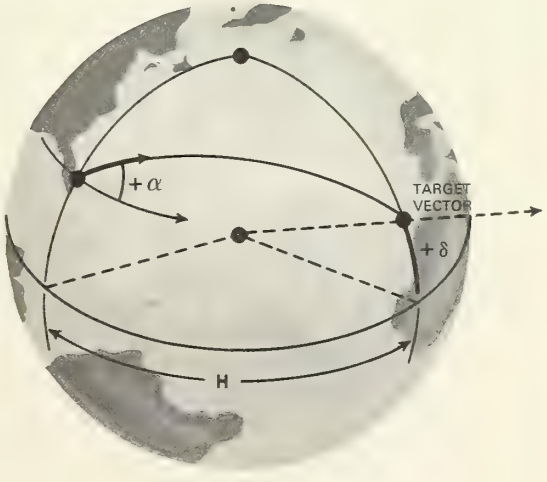
How do you launch into a geocentric planar trajectory from Cape Canaveral to a specified target vector? This family of curves demonstrates the interrelationships of the target vector declination, equatorial hour angle and launch azimuth. They can be used to estimate the launch requirements of lunar probes. For example, suppose a lunar vehicle launch is scheduled for July 17, 1968. At this time the declination of the moon will be + 10° (NASA Technical Note D-911). Assuming an hour angle of 80°, the launch azimuth can be found to be + 5°. The azimuth change for a ± 1 hr. launch window (±15° in H) will be $\alpha = -2°$ to $+12°$ as can be determined by moving along the $\delta = 10°$ line.


# ENGINEERS:

Plotting complex launches to the moon and planets is among scores of space-oriented activities in progress at Astronautics. We're also deeply involved with the development and design of boosters and vehicles for space exploration and travel. We're developing, too, the incredibly precise electronic systems necessary to guide and track and communicate with these probes.

Our constantly expanding efforts have created a number of outstanding positions for engineers with exceptional ability. If your interests and experience qualify you—if you'd like to work mind-to-mind with the top technical talent of the space age—we urge your immediate inquiry.

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics| Astronautics, 5781 Kearny Villa Rd., San Diego 12, California.

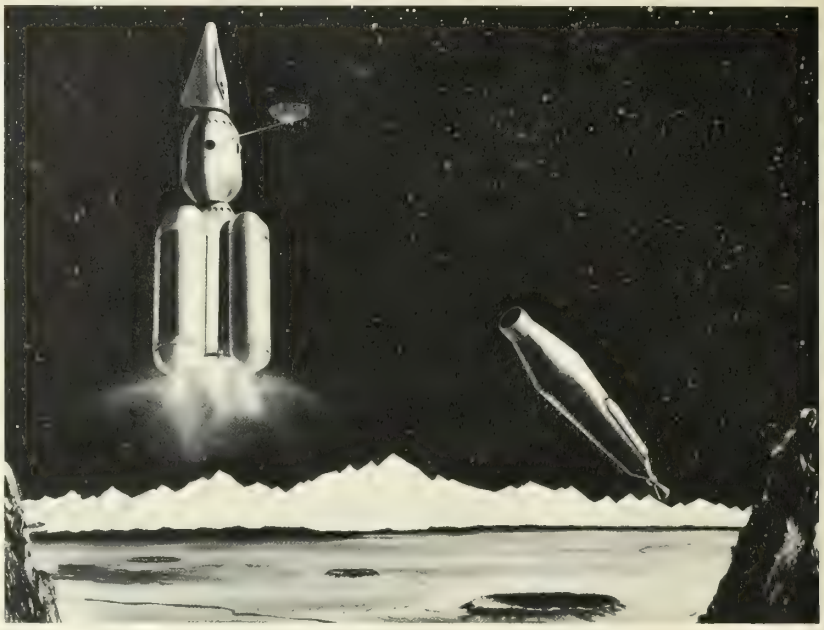



GD

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**LUNAR LANDING** This spacecraft conceived by General Dynamics | Astronautics is shown backing down onto the lunar surface, controlled by powerful retro-rockets, after its journey from the earth. The discarded second-stage fuel tank is shown at right. Large tanks, clustered at base of the capsule and clamshell re-entry glider vehicle, provide fuel for landing on the moon and take-off power for return to earth. The tanks also provide a measure of protection against space radiation for the crew. Rockets are arranged at slight angles to the craft to avoid problems in landing which might be caused by "digging" holes in the surface of the moon.



## DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

## AEROTHERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

## FLIGHT MECHANICS

Analytically talented graduate engineers at all levels required for staffing of new Flight Mechanics Development Section. Programs include aerospace vehicle guidance and automatic control, aeroelasticity, and aerophysics. Responsibilities of the Section also involve technical analyses and simulation work in support of all space vehicle programs at Astronautics.

## WEIGHTS ENGINEERING

BS in engineering or physics with two years of experience in the establishment of system and component weight allowances and controls. Will work with predesign, design, and test functions to control system and vehicle weight and balance.

## GUIDANCE AND TRAJECTORY ANALYSIS

Positions exist in the following three areas for specialists who are familiar with computer techniques, possess a degree in engineering, physics, or mathematics, and have at least two years of appropriate experience:

1. Development of guidance equations and techniques necessary to perform launch, satellite rendezvous, lunar landing, re-entry, and return to prescribed earth sites. Will investigate both automatic and manual techniques, and define the proper role of man in these maneuvers. Assignments also involve the development of techniques for defining optimum trajectories for aerospace missions using the calculus of variations, dynamic programming, and the method of gradients, plus the incorporation of optimization techniques into the development of guidance equations.

2. Investigation and organization of characteristics of lunar and interplanetary trajectories. Will interrelate such parameters as velocity requirements, launch window, time of flight, inclination angles, and trajectory characteristics at the target body. Will also design trajectories to satisfy prescribed mission requirements.

3. Development of techniques for determining the best estimate of spacecraft position and velocity from optical and radar measurements within the confines of a spacecraft computer using statistical filtering.

## OPERATIONS AND SYSTEMS ANALYSIS

Projects involve the study and development of advanced ballistic missiles and boosters, plus both military and non-military orbital and space systems. Responsibilities include advanced systems planning, conceptual design, and systems evaluation. Advanced degree preferred; three years of appropriate experience required.

## ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, nuclear-propelled space vehicles, earth-to-moon logistics bus, and space stations. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is required.

*If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5781 Kearny Villa Road, San Diego 12, California.*

GD

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# Navy Ponders Tactical Sea Launches

***Contract for Chrysler feasibility study stems from firm's pre-Polaris work; will cover hull motion, launch dynamics***

NAVY OFFICIALS are taking renewed interest in sea launch of tactical payloads into space with award of a second contract in this field to Chrysler Corp. The contract calls for a feasibility study of launching both research and development and tactical payloads.

The study is already underway. It is to cover motion studies of hulls, launching dynamics, launching techniques and the arrangement of the shipboard complex. The company's experience in the sea launch of rockets stems from its pre-*Polaris* work with the Navy on adapting the liquid-fueled *Jupiter* IRBM to surface ships. (The concept was later dropped in favor of the solid-fueled *Polaris* because of the hazards associated with storing liquid fuels aboard ships.)

• **Advantages of sea launch**—Primary reasons for the renewed interest in sea launches of rockets are flexibility, increased payload possibilities and tactical advantages which are attainable with ship launchings.

Unlike launching from one of the four major sites in this country, a vehicle launched from a ship can be prepositioned almost anywhere in the world to take advantage of special conditions. For example, if a payload is to be placed in a 24-hour, synchronous orbit from Cape Canaveral, considerable payload must be sacrificed in order to accommodate the more complex guidance equipment and increased propulsion required to dog-leg the payload into the desired orbit.

Utilizing a surface ship to launch the same payload from the equator, however, has several distinct advantages. Guidance requirements are less complex and therefore considerably lighter. Propulsion requirements are less, since it is unnecessary to change the initial launch plane through the launch site to the equatorial plane.

These less stringent constraints could create an additional payload advantage of almost 80% for low Earth orbits with a decreasing advantage as the orbital altitude increases. Part of this payload gain, of course, is attributable to taking full advantage of the Earth's spin at the equator—a velocity increment gain of approximately 180 ft./sec. over launching from Cape Canaveral.

Tactically, sea launches would enable the Navy to achieve optimum low-inclination orbits for some of its satellites. *Transit,* for example, when it becomes operational, will require a 22.5° orbit for ideal world-wide coverage. Since it is impossible to achieve less than a 28° orbit inclination in easterly launches from Cape Canaveral, the Navy has decided to launch the operational *Transit* from the Pacific Missile Range into polar orbit. Sea launch would eliminate this less-than-optimum navigational coverage by permitting the payloads to be launched at the desired inclination and in the desired direction.

Another tactical advantage would be the use of sea launches to improve the reconnaissance capability of the Fleet Commander. Under Projects *Yo-Yo* and *Albatross,* the Navy has studied the use of a one-pass reconnaissance satelloid to gather intelligence on enemy fleet deployments. These payloads—launched from surface ships attached to the fleet—would provide Navy commanders with up-to-date, long-range tactical information.

• **Astronautics ship concept**—Feasibility of launching rockets from ships at sea was well proven, the Navy feels, by its firing of *Polaris* missiles from submarines, the Observation Island and the Norton Sound. Also, the feasibility of shipboard tracking, telemetry and control has been demonstrated by the use of tracking ships throughout the space program.

What is needed is the design and construction of an integrated astronautics ship which would combine the launching and tracking functions.

This also is the chief disadvantage of the astronautics ship concept. It would necessitate development of techniques and equipment to perform at sea functions already mastered on land. In addition, new factory-to-launch techniques probably would be necessary to insure minimum handling and maximum reliability of the launch vehicles.

Under sponsorship of the Navy's Bureau of Ships, however, various hull designs have been considered—ranging from aircraft carriers to Victory ships. The larger ships were rejected because of the high cost of converting and operating them; the smaller hulls were considered too small.

A seaplane tender (AV) was finally selected as ideally suited for an astronautics ship. It has both the speed and seakeeping ability to operate effectively in navigable waters throughout the world. At the same time, it has enough internal volume to house the launching crew, vehicle storage and handling facilities and large radar tracking and microwave communications and telemetry antennas. The launch pad could be easily fitted on the fantail.

The astronautics ship concept was outlined by Lt. Cmdr. E. B. Mitchell and Lt. Cmdr. B. I. Edelson in the *Naval Engineers Journal* for August, 1962, and by Edelson in the *A.S.N.E. Journal,* February, 1961.

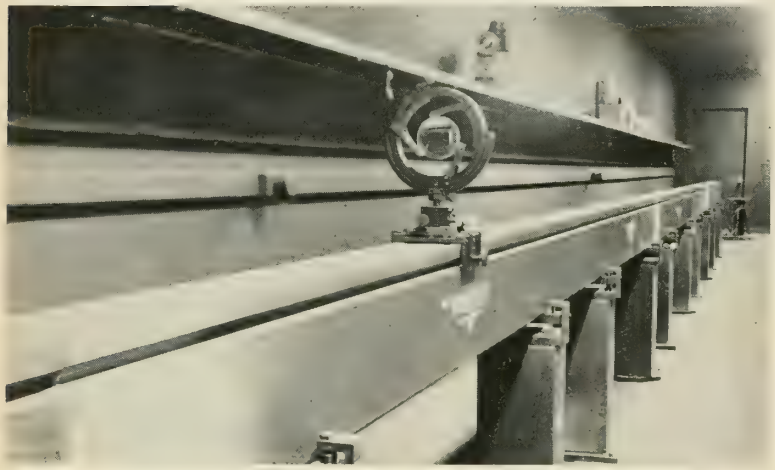
• **Launch vehicles**—Under the concept, the ship would be fitted to launch the still-to-be-approved *Seascout.* This is a four-stage solid-propellant vehicle differing from NASA's *Scout* in that it uses the first two stages of the *Polaris* and the last two stages of the space agency vehicle. The payload capability of *Seascout* is not discussed, but it is estimated that the launch vehicle would be able to put several thousand pounds in a low Earth orbit.

Although it would be outfitted for *Seascout,* the Navy says that *Scout, Blue Scout* and *Minuteman* could be launched from the ship, if desired. Smaller space probes, such as *Aerobee* and *Astrobee,* also could be fired.

Recognizing the hazards of liquid-fueled vehicles, the Navy nevertheless claims that vehicles of the *Saturn*-class could be launched at sea. Under a concept proposed by the Bureau of Yards and Docks, a floating drydock would be used as the launch pad while a second ship anchored close by would provide the checkout, launch, tracking and telemetry facilities. This concept would be particularly attractive, the Navy feels, for the launching of nuclear rockets. ⌗

# Black Granite May Fulfill Need for Lab Standard

by Richard van Osten



*BLACK GRANITE optical rails have shown deflections of less than 0.00001 in. over 10-ft. lengths while supporting a 1000-lb. centered weight for 30 days.*

HAWTHORNE, CALIF.—The use of black granite in optical rails promises to help greatly in providing a critical aerospace industry need—modern laboratory standards for evaluation and development of optical systems.

The concept of exploiting black granite, long a standard material for high-precision surface plates, grew out of a cooperative program by the Nortronics Div. of the Northrop Corp. and Collins Microflat Co., Inc. Nutronics studied materials other than the conventional steel and determined that black granite was a near-ideal material for the purpose. Collins Microflat was approached to produce the rails to Nortronics specifications (it has since been licensed by Northrop to produce granite rails for other companies). The concept is being patented by Northrop.

The first set of primary standard rails, 60 ft. long in six 10-ft. lengths, is now being installed and checked out at Northrop's Research Laboratories, Palos Verdes, Calif. The Nortronics rail installation is Air Force-owned, and replaces earlier AF-owned steel rails.

Early Nortronics planning for the *Skybolt* guidance system helped to bring new attention to the need for better optical rails. The division was faced with similar problems on allied projects, including long and short-range Earth sensors for JPL, an optical-type star simulator, a space vehicle star tracker and a space vehicle sun sensor.

Nortronics engineers point out that current requirements in analyses of simulated star signals for intensity, focus and image quality are an industry-wide problem. Today's reliability performance needs would not have been possible even two or three years ago.

• **Vibration trouble**—Optical rails have been around a long time—as a standard lab tool and, more recently, for system evaluation programs as well as upstream tools for analyses of optical-type simulators aimed at checking out and calibrating end systems. Biggest problem has been the vibration characteristics of existing steel rails as related to improvements in simulators and photometers. The problem has grown to where star simulation cannot be made within present standards on steel rails.

Nortronics studies showed steel rail vibration amplitudes as high as 20 to 30 arc seconds over extended periods. Precise measurements of image quality and focus has been impossible, especially when using a 10-arc-sec.-diameter pin hole aperture. With an internal damping factor some 15 times greater than steel, black granite should eliminate this problem.

In the *GAM 87A* simulation program, Nortronics uses photometric and image analysis equipment mounted on optical rails in a room that can be completely darkened. The test equipment and the unit under test are locked in position on the rails to provide focus and intensity conditions. After accurate adjustment of optical alignment, intensity and image analysis are measured. From final alignment to test completion, mechanical stability is essential. Because photoelectric measurements are made in a series, alignment cannot be verified until series completion. Any change after an alignment check will require repetition of the whole thing.

The need for improved performance has become more urgent with increasing numbers of light standards, star sky simulators, photometers and instrument telescopes which require testing and analysis. Low values in image qualities can easily result in a 10% error in system calibration, in discrepancies between simulators, and between different instrument telescopes.

Steel optical rails, in general, offer tolerance ratings on the order of 0.002 in. The Nortronics steel unit has a tolerance of 0.003 in 8 ft. But testing of the *GAM 87A* simulator unit involves tolerances of only 0.0005 in. in 10 ft. The black granite rails can be built to within this tolerance, and can maintain all surface dimensions at temperatures from below zero to 1000°F without warp or distortion.

• **Highly stable**—The granite rails are expected to pay big dividends in time savings because of the material's stability. In one test, deflection of less than seven millionths of an inch was measured in a 10-ft. rail upon which a 1000-lb. weight had been centered for 30 days. Stability provides test repeatability.

The repeatability factor may offer the greatest advantage in both precision and manhour cost. In an initial reading of the simulator, for aperture positioning, 48 position readings can be made in eight hours. A second reading for repeatability, aperture alignment, runs to 24 position readings and four hours. With steel rails these tests may have to be repeated as many as six to 10 times and a time investment of anywhere from 60 to 96 hours.

Nortronics calculated that the granite rails have a productivity ratio of 6:1 over steel units. Test times for other readings are similarly reduced.

Other advantages of the granite rail include lack of oxidation, a problem constantly facing steel rail users. Maintenance cost, for example, will probably require only one hour per month, based upon present experience with black granite surface plates. ⁂

# New Furnace Advances Refractories

## *Centrifugal unit aids in studying behavior of liquid elemental metals*

by John F. Judge

INVESTIGATIONS beyond the 5000°K existence range of chemical compounds—now under way at the Research Institute of Temple University in Philadelphia—may provide information crucial to many advanced concepts in space propulsion and allied fields.

Scientists there are conducting high-temperature studies into the chemical behavior of liquid elemental metals beyond the practical limits imposed by solid refractory containers.

Even the high-temperature-containing capabilities of refractories such as tungsten, thorium oxide and graphite cannot be fully used as containment means because of chemical reactions between the container and the substance under study, and also because of thermal shock.

The method chosen by Dr. A. V. Grosse, president of the Institute, and his staff involves the combination of a noble-gas plasma jet and a centrifugal furnace. The substance under investigation floats on a bath of refractory material held against the outer rim of the circular furnace by centrifugal force.

The problem of containment in liquid containers was solved in principle in 1950, with the design of a centrifugal chemical reactor consisting of a large steel pipe lined with $Al_2O_3$ bricks. The unit was rotated horizontally at a few hundred rpm while aluminum metal reacted with $O_2$ to form $Al_2O_3$ at an average temperature of 3800°K.

• **Method's limitations**—But the limiting disadvantage of the chemical furnace is its need to be coupled to an exothermic chemical reaction—rendering it impossible to study anything but the reaction taking place.

Institute researchers eliminated this by using a plasma jet as a heating source, with a noble gas such as helium or argon operating in the 5000° to 15,000°K range.

The furnace consists of a steel cylinder approximately 12 cm in diameter surrounded by a water jacket. The unit is rotated on ball bearings by a 1-hp variable drive motor with a range from 500 to 1500 rpm.

The interior of the steel pipe can be filled with any suitable insulation material. The reaction section is composed of a number of coaxial tubes of any oxide or graphite.

A prerequisite to successful operation of any centrifugal reactor is that the density of the liquid reactant be less than that of the liquid container. This governs the choice of the reaction-area materials.

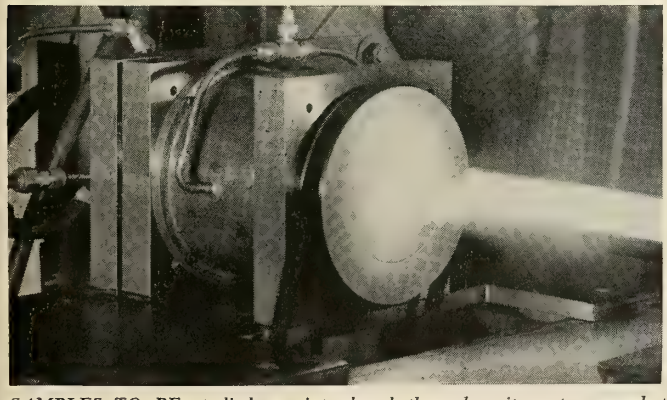
• **Operation described**—An $Al_2O_3$ tube was first melted by heating in the plasma jet. The liquid oxide could be observed through the exit port. A solid rod of aluminum of known weight was then introduced at a slight angle through the exit port. Melting in a few seconds, it floated on the liquid oxide and came to a boil in three minutes, distilling out through the exit port. The process was run at one atmosphere.

On cooling the furnace, the researchers found the innermost oxide tube had melted over a length of about 10 cm and the remaining aluminum metal formed a sharp cylindrical band on the $Al_2O_3$. This band was about 3 cm wide and approximately 3 mm thick, with both phases perfectly defined and separate. Institute scientists have also melted a thorium oxide tube.

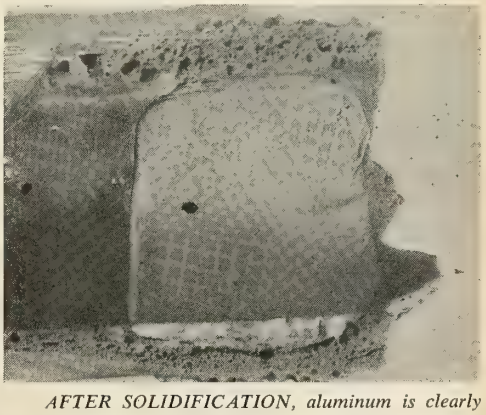
The ratio of the vapor pressure of the container to the total pressure can be adjusted as desired by operating the plasma jet and the furnace at a higher total pressure.

The process is not particularly suited to determining physical properties, such as density and electrical resistivity, because of imperfect geometry. These measurements can be made in a centrifugal furnace heated by ohmic resistance. The Institute is working on such a reactor.

The development provides a route to extend research on chemical reactions in the liquid phase to a much higher temperature range than was previously possible. ⌗



*SAMPLES TO BE studied are introduced through exit port, somewhat obscured here because of the high operating temperature. Furnace consumes 8 to 15 kw power with a helium flow between 15 and 30 liters per minute.*



*AFTER SOLIDIFICATION, aluminum is clearly defined inside the aluminum oxide tube. Light gray area is aluminum.*

# Two Can Easily Land Moon Capsule

***Langley studies indicate one pilot would be too busy, over-cautious during touchdown***

**by Heather M. David**

NASA REPORTS it has determined that two pilots can easily land a capsule on the Moon.

In a series of pilot studies in simulated lunar landing vehicles at the space agency's Langley Research Center, the soft landings were made at velocities up to 10% higher than the computed goal. This was, however, considered to be within a safe margin.

Both one- and two-pilot studies were conducted, NASA says, and accuracy and fuel consumption were about the same for both. However, the researchers concluded that:

—The single pilot was extremely busy during touchdown, as he scanned and interpreted displays and manipulated thrust and attitude controls. This led to over-cautiousness and resulted in prolonged periods of hovering—and even some climbing—before landing.

—The entire procedure was "rather easy" for two pilots. In this mode, one pilot operated the throttle, the other the attitude control system.

The pilots generally landed with touchdown velocity components of less than 4 feet per second and within a range of about 2000 feet of the target site.

No automatic damping or automatic control was provided in the simulation. The subjects were required to land the vehicle from a circular orbit at about 50 miles above the Moon. Six equations of motion were used, permitting all six rigid body degrees of freedom of the vehicle.

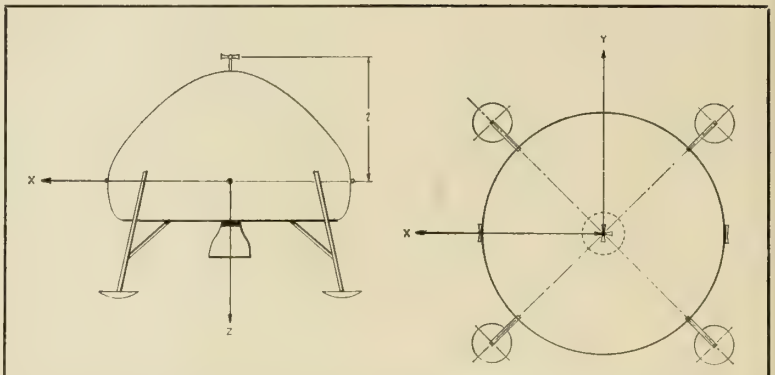



*DIAGRAM SHOWS lunar landing vehicle used in Langley Research Center studies.*

The lunar landing vehicle (see diagram) was a squat, circular body. The cockpit instrument panel supplied data on:

• Altitude — near touchdown (around 10,000 ft.) a three-hand altimeter provided information within two feet.

• Rate of descent—a three-hand meter showed rate of descent within 0.2 ft./sec. The meter was scaled for 1000 fps.

• Circumferential velocity—a galvanometer-type meter displayed circumferential velocity in combination with automatic switching. Three scales were available: 0-6000 fps, 0-600 fps, and 0-60 fps. This could be read within one fps.

• Vehicle attitude—a vernier pitch attitude indicator scaled to read from 85° to 95° could be read to a fraction of a degree.

A number of trajectories were investigated, among them a nominal gravity-turn trajectory, in which thrust was always directed against the velocity, vector, and several off-nominal trajectories.

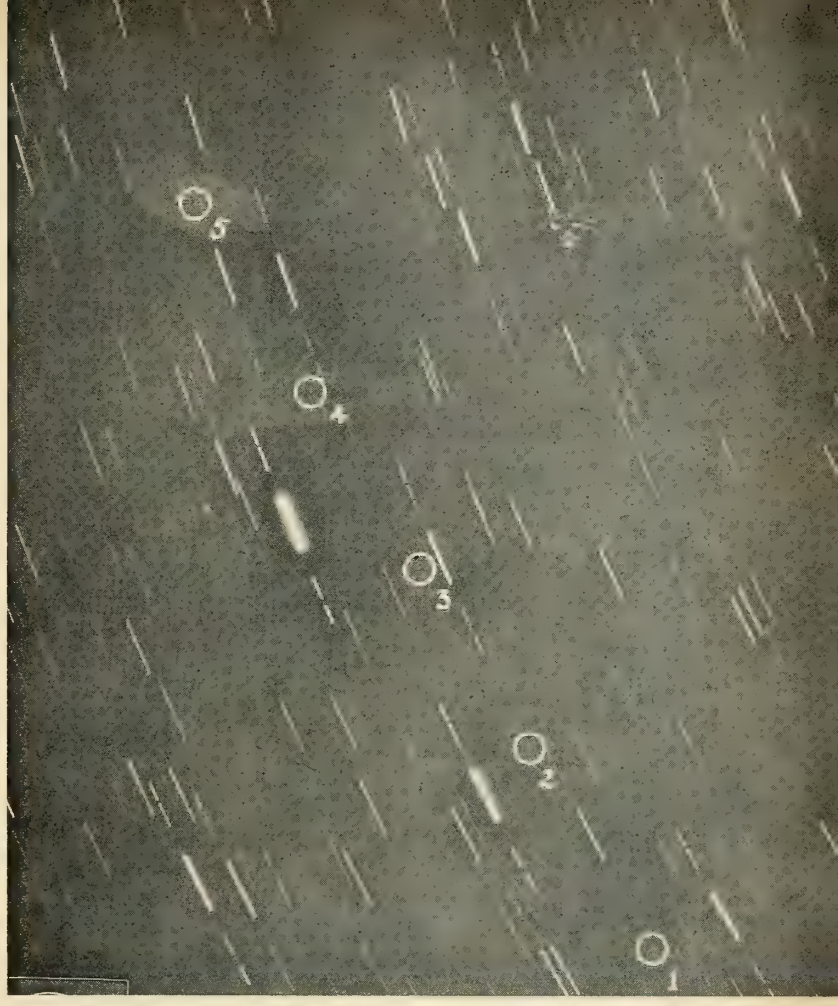
All landings were instrument landings. Range and altitude were uncoupled by using the throttle for range control and the attitude control to adjust altitude. During vertical descent, the throttle was used to control altitude, and rate of descent, and altitude control for range and circumferential velocity. ⁂



## *Huge Solar-Energy Collector Readied*

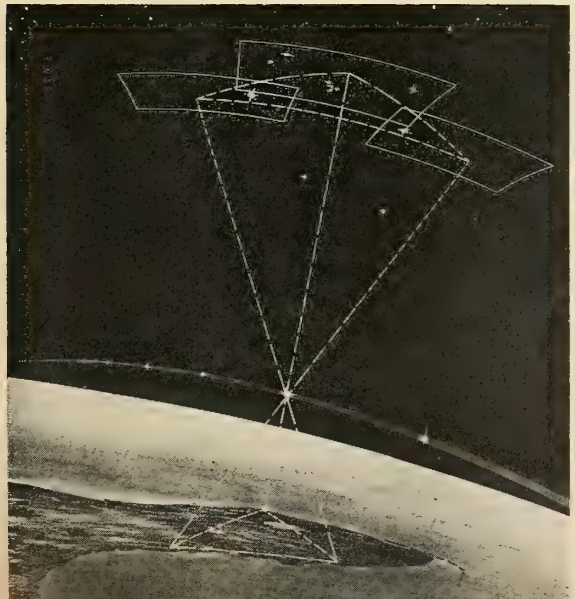
*THIS REFLECTOR, said to be the largest ever built for solar-energy collection to power future spacecraft, is being built at Goodyear Aircraft Corp.'s Arizona Div., Litchfield Park. Workers apply strips of aluminized film to a giant form on which the 45-ft. inflatable foam rigidized collector is taking shape. Concentrator will supply 15 kilowatts of power — enough to supply the requirements for three modern homes. Ground tests, part of the Air Force's Advanced Solar Turbo Electric Concept, are set for early next year.*

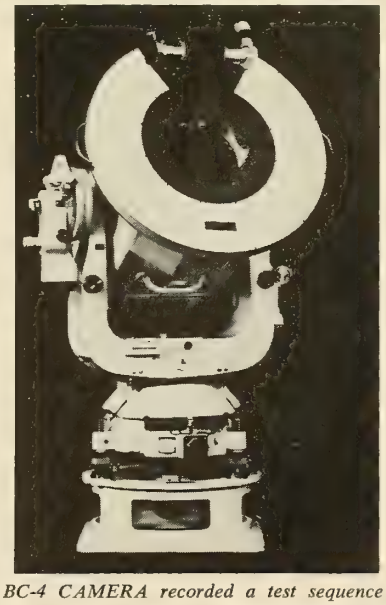
# ANNA Flashes Captured On Film




*SNAPPED AT 3:30 a.m. Nov. 2, this photo is believed to be the first in which the geodetic satellite ANNA was identified. Photo was taken by the U.S. Coast & Geodetic Survey at Aberdeen Proving Ground, Md. As satellite was only 50 microns in diameter on the photo plate, C&GS technicians in Washington, D.C., required precise photogrammetric instruments to analyze the photos obtained.*

*TO ILLUSTRATE how ANNA is pinpointed against a star background, drawing shows cameras at three widely separated points simultaneously recording the satellite's position against the sky.*





*WILD BC-4 CAMERA recorded a test sequence of five flashes from ANNA. Shutter operation for the camera is synchronized with a common time reference (VLF time signals) to within a millisecond.*

# Improvements Foreseen In Microwave Receivers, Transistors

## *Advancement also forecast for maser, tunnel-diode and parametric amplifiers*

by Michael Getler

BOSTON—Continued improvements in low-noise solid-state microwave receiver systems and transistor componentry were predicted by scientists and engineers at the 16th Northeast Electronics Research and Engineering Meeting (NEREM) held here earlier this month (M/R, Nov. 12, p. 16).

New progress in development of maser, parametric, and tunnel diode amplifiers—already proceeding very rapidly—was forecast in a paper presented by Sy Okwit of Airborne Instrument Laboratory in Long Island, N.Y.

Okwit, discussing the current maser state of the art, pointed to introduction of the traveling-wave maser as the major factor in elimination of many of the stability gain and tuning problems normally associated with cavity masers.

Also, he noted that the coming availability of closed-cycle refrigeration systems should aid substantially in solving the logistics problems associated with maser cryogenics. This could become especially significant with development of small ComSat ground stations dependent upon maser receivers for adequate signal reception.

Elimination of bulky electromagnets through introduction of new high-field/high-current density, lightweight superconducting alloys should also contribute to eventual maser use in airborne systems, the author reports.

Many engineers believe this airborne application is still considerably in the future, with most of the current receiver effort likely to remain focused on ground station applications.

• **Future systems**—Discussing characteristics of future maser amplifiers, Okwit expects devices will be made available with greater-than-octave tuning ranges as well as instantaneous bandwidth greater than 40%. He also predicts that use of low-temperature ferrimagnetic limiters as protection devices will aid considerably in solving maser recovery-time problems.

The author feels that a completely solid-state maser system can be achieved by using the recently discovered superconducting thin-film tunneling effect as a microwave or millimeter pump source. A proposed configuration consists of a parallel-plate transmission line containing a distributed tunneling region evaporated directly on the paramagnetic crystal and immersed with the maser in a common bath.

Also noted by Okwit are some of the new maser materials which yield relatively high inversion temperatures, allowing operation at higher bathe temperatures without loss of low-noise qualities. In addition to this obvious advantage, the author predicts this will extend efficient maser operation to the sub-millimeter range. Use of cross-relaxation and optical pumping techniques, the author claims, can circumvent current unavailabilities in sub-millimeter pump sources.

Commenting on parametric amplifiers, generally considered to be second to masers in terms of low-noise performance, Okwit points out that most engineering effort to date has been directed toward improving low-noise performance and increased fractional voltage gain-bandwidth products. In the first case, effort has been pointed primarily at refrigeration and materials studies, and in the latter case at cascading amplifier stages, multiple-tuned circuits, and push-pull diode-type circuits.

However, Okwit points out that additional work should be aimed at development of traveling-wave and backward-wave amplifiers. He feels that these devices will be useful in a host of receiver system applications. In particular, he cited one new class of BWPAS reportedly capable of rapid tuning over greater-than-octave tuning ranges with the output frequency remaining constant.

Okwit also looks for major improvements in tunnel diode materials and amplifier configurations in the future. New research into cooled diode characteristics may turn up significant gains for the devices, he reports. Also, tunnel diode amplifiers may become extremely useful in the millimeter region in the near future, since the required negative resistance can be achieved without the high-frequency pumping sources which are not now available in this frequency range.

• **Transistor capabilites** — A paper by J. M. Goldey of Bell Telephone Laboratories, Inc., summarizing the current transistor state of the art concludes that the devices are approaching their ultimate capability with respect to frequency performance and noise level, but that considerable room for growth exists in power-handling capabilities, low-power operation, and reliability.

Goldey predicts that application of superior diode encapsulation techniques to transistors will be a major factor in improving reliability of the components. Improvement in transistor low-noise performance, the author believes, will come with greater understanding of the surface-generated L/F noise. Other prime sources, shot and thermal noise, are much more widely understood.

Despite recent impressive laboratory tests with various transistors operating at low power, the author maintains that these levels are nowhere near the theoretical low-power limit for high-speed switching operations. Goldey also expects that current power-handling limits of roughly 300 watts for transistors will also be exceeded, primarily through improvements in the power-dissipation capability of the transistor. He also cautions against the severe technical problems involved in achieving high power at high frequency.

Discussing frequency performance, Goldey asserts that germanium transistors are now approaching their maximum capability with respect to frequency cut-off, as are silicon devices with values about one-half those of germanium transistors. ⌗

## Industry Offices Opened

An Office of Industrial Cooperation has been set up at Oak Ridge National Laboratory to provide liaison between ORNL and private firms seeking information on R&D at the laboratory. One of the nation's largest nuclear-energy laboratories, ORNL is operated by Union Carbide Corp. for the Atomic Energy Commission. . . . *Philco Corp. has opened new offices in Arlington, Va., for the Systems Technological Center of its Communications and Electronics Div. Philco is hiring scientists and engineers from that area to meet the needs of the expanded operation. The center's work concerns recently expanded classified military programs.* . . . Kawecki Chemical Co., manufacturer of rare metals and chemicals, has established a technical sales office in Chicago to serve growing demands for its products by electronic, metallurgical and nonferrous metals industries of the North Central states. The office will also serve Midwest customers of a wholly owned KCC subsidiary, Accurate Specialties Co., as well as Penn Rare Metals Co., in which KCC owns a 50% stock interest. . . . *CryoVac, Inc., Columbus, Ohio, has opened a new West Coast office in Los Angeles to handle sales and contract administration for the western states. CryoVac has furnished many of the cryogenic systems used in space simulators for testing satellites before launch. Howard Altman will head the new office.*

## Industry Facilities

A newly opened production facility of Rocket Research Corp., Seattle, is producing instrumentation for NASA's Goddard Space Flight Center. RRC also operates a rocket laboratory for development work on new rocket products under prime contract from the Army and subcontracts from industry. The firm's facilities include the 27,000-acre Whisky Dick Rocket Test Center in central Washington State. . . . *General Dynamics/Pomona is boasting that it has the "cleanest clean room in the world," thanks to a new method of air circulation known as laminar flow. The 600-sq.-ft. area, used for sensitive parts assembly, is reportedly four times cleaner than Class IV rooms, the highest present dust-free classification.* . . . Hitchiner Manufacturing Co., Milford, N.H., producer of investment castings, has begun volume production operation of what it calls the most completely automated facility for casting precision metal parts by the ceramic shell technique. The plant reportedly has a capacity three times that of conventional installations of similar size and can convert 7200 lbs. of metal per shift into finished parts weighing from a few ounces to 100 lbs.—with accuracies as high as a few thousandths of an inch. . . . *Universal Match Corp. will build a new plant at Goodyear, Ariz., for its Unidynamics Div. The facility—to be built on a 24-acre tract near Phoenix—will engage in research, development and manufacture of propellant-actuated devices and systems. The plant is expected to be operational by late 1963.*

## Company Representatives Named

Electronic Memories, Inc., Los Angeles manufacturer of ferrite cores and memory components and complete core memories for missile/space and commercial use, has named Advanced Components, Inc., Liverpool, N. Y., to be its representative for New York State, excluding Westchester County. . . . *Consolidated Systems Corp., Monrovia, Calif., associate company of Bell & Howell Co., has appointed Traid Corp., Encino, Calif., as world-wide distributor for the CSC line of standard photo-instrumentation products, including spare parts and field services. This will enable CSC to focus on its systems engineering skills in the electro-optical field.* . . . Tektrol Co., Reseda, Calif., will provide complete manufacturer's representative service throughout the Southern California area for Nilsen Manufacturing Co., Haines City, Fla. Nilsen is engaged primarily in design, development and manufacture of its Variogon high-frequency phase shifting instruments, components and accessories. . . . *General Kinetics Inc., Arlington, Va., has signed an agreement with Altec Service Co., New York City, calling for Altec to provide nationwide service for GKI's specialized tape-related products and systems. Altec now serves more than 5000 client producers of electronic equipment.*

## Bought, Sold, Traded, Merged

Superior Tool & Die Co., Detroit, has been merged into Bethlehem Corp., Bethlehem, Pa. Bethlehem is now producing environmental-test and space-simulation equipment for government and industry, as well as heavy equipment for chemical, cement and turbine industries. . . . *West Instrument Corp., Schiller Park, Ill., has bought the assets of the Technique Associates Div., Duncan Electric Co. for an undisclosed cash amount.* . . . International Telephone & Telegraph Corp. will trade 112,000 ITT shares for the assets of National Computer Products, Inc., Lawrence, Mass, producer of semiconductors and other components. More than $4 million is involved in the transaction.

## AFOSR Basic Research Awards Revealed

The Air Force Office of Scientific Research awarded basic research grants and contracts of $13,835 to three firms during September. Awards to universities and nonprofit groups in the same month in the same category were more than $400,000, AFOSR figures reveal. Informational sciences awards went to Documentation Research, Inc., Bethesda, Md., ($13,835) and to Herner & Co., Washington, D. C., ($13,912). Advanced Technology Div. of Electronic Communications, Inc., Goleta, Calif., received a $13,833 award for work in applied mathematics.

# AWARDS

## AIR FORCE

$13,810,257—**Sylvania Electric Products, Inc.,** New York City, for production of electronic equipment.

$8,163,000—**Hughes Aircraft Co.,** Culver City, Calif., for production of missile test equipment.

$5,004,321—**General Dynamics Corp.,** New York City, for research and development on *Atlas* missiles.

$3,206,141—**Douglas Aircraft Corp.,** Santa Monica, Calif., for *Skybolt* missile spare parts.

$2,595,000—**Systems Development Corp.,** Santa Monica, Calif., for training programs.

$600,000—**Adler Electronics, Inc.,** New Rochelle, N.Y., for engineering services, furnishing and installing communications control systems for the Atlantic Missile Range.

$205,266—**National Research Corp.,** Cambridge, Mass., for solid-propellant development.

$140,000—**Electrada Corp.'s Data Products Div.,** Los Angeles, for DATACOM systems for integration in an intelligence data-handling system.

$122,335—**Ryan Aeronautical Co.,** Lindberg Field, San Diego, Calif., for technical data to support CFE applicable to Q-2C target drone.

$97,944—**Thiokol Chemical Corp.'s Reaction Motors Div.,** Bristol, Pa., for advanced solid propellant development.

$66,999—**Excelco Developments, Inc.,** Silver Creek, N.Y., for an evaluation of high-strength steel for large-diameter rocket motors.

$30,225—**Emory Design and Equipment Co.,** Birmingham, Ala., for valves used on general missile and aircraft ground servicing equipment

## ARMY

$53,921,660—**Martin-Marietta Co.,** Orlando, Fla., for continued production of the *Pershing* weapons system.

$1,817,000—**Cornell Aeronautical Labs., Inc.,** Buffalo, N.Y., for a study of effective means of delivering chemical agents.

$1,733,920—**Western Electric Co.,** New York City, for field support of *Nike-Hercules* weapons system.

$999,985—**Martin-Marietta Co.,** Orlando, Fla., for a study of a ballistic missile defense concept for the Advanced Research Projects Agency as part of Project *Defender*.

$300,000—**Information Handling Services, Inc.,** Denver, for indexing, coding and microfilming 100,000 missile parts drawings for use by engineers at Redstone Arsenal and at selected contractor plants.

## NAVY

$15,570,000—**Applied Physics Laboratory, The Johns Hopkins University,** Silver Spring, Md., for continued research and development on ordnance and related equipment.

$1,578,427—**Sanders Associates,** Nashua, N.H., for classified electronics equipment.

$1,128,928—**General Dynamics,** Daingerfield, Tex., for continued research and development on guided missiles.

$213,600—**General Steel Industries, Inc.,** Eddystone, Pa., for castings for missile tube upper sections.

## NASA

$1,512,731—**Grafe-Wallace,** a joint venture between Grafe and Associates, Inc., Boise, Idaho, and Wallace Process Piping Co., Inc., Denver, for fabrication and erection of a flame detector for the *Saturn C-5* booster static test tower.

$750,000—**Ets-Hokin Galvan, Inc.,** San Francisco, for installation and re-electrification of 2 million square feet in the Michoud Fabrication Plant at New Orleans.

$653,700—**Ets-Hokin & Galvan, Inc.,** San Francisco, for complete design, testing, procurement and installation of all materials, equipment, and services for a 138KV power substation at the Manned Spacecraft Center at Houston.

$154,938—**McDonnell Aircraft Corp.,** St. Louis., for study of spacecraft for use with *Saturn C-5* launch vehicle.

$144,000—**Space General Corp.,** El Monte, Calif., for development of an advanced guidance subsystem for space vehicles.

$38,805—**Thompson Ramo Wooldridge, Inc.,** Cleveland, for research and development of lithium and lithium hydride propellant feed systems for electric propulsion systems, Phase II.

$37,446—**Parker Aircraft Co.,** Huntsville, Ala., for eight items of union, elbow and adapter for the Marshall Space Flight Center.

$31,800—**W. R. Fairchild Co., Ltd.,** and **J. W. Snowden Construction Co.,** a joint venture, Hattiesburg, Miss., for test piles for test stand S-1C at Mississippi test facility.

## INDUSTRY

$15,000,000—**Rohr Corp.,** Chula Vista, Calif., from **Boeing Co.,** for components KC-135 and C-135.

$750,000—**CryoVac, Inc.,** from **Douglas Aircraft Co.,** for design, fabrication, and installation of cryogenic systems for the space simulation test facility at Huntington Beach, Calif.

$350,000—**Wauntic Industries, Inc.,** San Carlos, Calif., from **Avco Corp's Lycoming Div.,** for production of re-entry vehicle separation systems for the *Minuteman* missile.

$150,000—**Bendix Corp.,** Detroit, from **Lockheed-Georgia Co.,** for supply control valves to be used on the C-130 *Hercules*.

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Chief, Bureau of Ships
Department of the Navy
Washington 25, D.C.

The Bureau of Ships under RFP 622A-31622(S) is negotiating with Westinghouse Electric Corp., 1625 K St., N.W., Washington, D.C. for approximately 400 man days of engineering services to assist with installation and checkout of propulsion equipment manufactured by Westinghouse under an existing bureau contract. It is suggested that small business firms or others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.

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Directorate of Procurement
Rome Air Development Center
Attn: RAKS
Griffiss Air Force Base, N.Y.

Research and development sources sought. Organizations having research and development capabilities in the specific areas listed below are invited to submit complete information to the Purchasing Office listed above. Responses should reference the code number found at the end of this notice. Responses should include the following information: total number of employees, professional qualifications of scientists, engineers and personnel specially qualified in the R&D area outlined, and description of general and special facilities, an outline of previous projects including specific work previously performed or being performed in the listed R&D area and a statement regarding industrial security clearance. Although interested parties need not furnish general information which they know is on file with the Center, they should include all information which they want considered in the evaluation of their qualifications for this specific procurement. This is not a request for proposal. Respondents will not be notified of the results of the evaluation, but the sources deemed fully qualified will be considered when Requests for Proposals are solicited. The specific technical area for which capability is sought is for the study, design and technique development of an electronic precision early launch phase tracking system capable of profiling missile trajectory data at altitudes of approximately 500 to 60,000 feet, with a data accuracy on the order of .02 feet per second. It will have all weather operational real-time readout capabilities. No special facilities required. Sources solicited will require SECRET security clearance. L-A-352.

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Secondary Items Branch
Procurement Div.
Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

Shield, GM, launchers, M2 Ord. Part. No. 9152676, 27 each. IFB-1XXF-ORD 01-021-63-10198B. Bid opening 12-11-62. Drawings and bid sets available from nearest Ordnance Dist. An additional quantity of 27 each is being reserved for labor surplus area.

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U.S. Army Engineer District, Norfolk
Foot of Front St.
Norfolk 10, Va.

*Nike-Hercules* improvement kit, special AAA site N-85C, Norfolk Defense Area, Va. Lot—IFB ENG-44-110-63-13. Bid opening 11-27-62. (A) Site preparation, including removal of concrete slabs. (B) Construction of 50 foot target ranging radar tower, complete, including concrete foundation and cast-in-place concrete piles. (C) Site improvement and miscellaneous items including grading, drainage, sidewalks and electrical distribution.

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Bureau of Naval Weapons
Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Westinghouse Electric Corp., Sunnyvale, Calif., to furnish a production quantity of MK 21 launcher systems for *Polaris*. Award will be made on the basis of a follow-on action to an existing contract with the above firm who developed the systems. This notice is being made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting should contact the above firm, referencing PR SP-1098-63. BuWeps Synopsis No. 135-63.

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Hq. Space Systems Div. (SSBKS)
Los Angeles, Calif.

Provide, install, checkout and maintain the instrumentation and control system for Complex 1-36 at Edwards Air Force Base, Calif. for the solid motor development portion of program 624A—1 system. Deliveries to Edwards Air Force Base. Request for proposal No. 04-695-63-142Q has been issued to the following firm: United Technology Corp., P.O. Box 358, Sunnyvale, Calif. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm. This is not a request for proposal.

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National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

Seeks sources with capability and broad experience in fabrication, erection and installation of massive and extremely complex electromechanical steel structures for projected launcher umbillical tower requirements. These structural steel towers (estimated at 6 million lbs. weight) consist of a launcher portion 163′ x 140′ x 20′ supporting a 400′ tower 60′ square at the base and including extremely complex electronic, mechanical, hydraulic and pneumatic systems. Industrial firms having required capability and experience for fabrication and installation of massive steel structural systems similar to the launcher-umbillical towers described here are invited to indicate their interest as a potential source by letter to the National Aeronautics and Space Administration, Launch Operations Center, Procurement and Contracts Office, Cocoa Beach, Fla. Attn: Mr. Walter Struhar. Closing date 11-23-62.

U.S. Navy Ordnance Supply Office
Mechanicsburg, Pa.

Launcher, rocket, LAU-10A, empty *(Zuni)*, in accordance with various BuOrd and BuAer drawings and specs—9428 each. Delivery 8000 to NAD, McAlister, Okla., and 500 each to both NWS, Yorktown, Va., and NAD, Concord, Calif. IFB 195-307-63 (K) B. Bid opening 12-12-62. An additional quantity of 9428 is being reserved for a labor surplus area under a partial determination.

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Hawk Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

Approximately 5550 lines of parts and components needed to support European manufacture of the major items under *NATO-Hawk* program: missile, OMS GSE crew chief distribution box; pulse acquisition radar/battery control center; assault fire command control; range only radar, FME Shops 2 through 7, telemetering. Delivery June 1963 through September 1963. Duplication of initial investment, special tooling and facilities plus the nonavailability of drawings and specifications adequate to support competitive procurement precludes award to other than the prime contractor: Raytheon Co., Willow St., Waltham, Mass. All inquiries relative to subcontracting must be referred to the above listed firm.

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Ogden Air Materiel Area
Attn: Directorate of Procurement and Production
Hill Air Force Base, Utah

Shipping and storage containers for *GAR-11A* missiles, model 52SC-1—427 each. Delivery to Tucson, Ariz. RFP No. 42-600-63-1269Q. Approximate RFP due date 12-7-62. Adequate drawings and specs are not available and will not be furnished. Requests for proposals have been issued to the Royal Jet Co., 1035 Westminster Ave., Alhambra, Calif. For further information contact W. S. Pach/OOPAM, Hill Air Force Base, Utah.

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Directorate, Procurement and Production
Middletown Air Materiel Area
Olmstead Air Force Base, Pa.

Contract technical services for MG10, MG13 and MA-1 AWCS systems applicable to F101 and F106 weapons systems. GAR 1 and 2 missiles by 13 technical reps for 128 man months. Negotiations will be conducted with Hughes Aircraft Co., International Airport Station, P.O. Box 90515, Los Angeles, Calif. This is a continuation of contract AF 36(600)-10667. Inquiries must refer to RFP 36-600-63-4061. For information only. No RFP available.

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National Aeronautics and Space Agency
Moffett Field, Calif.

Heat exchange. Characteristic determination of eight radiation sensors to be performed in a vacuum range minus 100 degrees F to plus 100 degrees F, with plus or minus ½ milliwatt accuracy. Lot—IFB A-6419. Bid opening 11-20-62.

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Mauler Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

Issuance of a planning proposal for initiation and implementation of a PERT/COST system. Indefinite quantity of PERT networks and associated data. Delivery through July 1963. Deliveries to Army Missile Command, Redstone Arsenal, Ala. Nonavailabiilty of *Mauler* system cost data adequate to support competitive procurement precludes award to other than prime contractor, General Dynamics/Pomona, a division of General Dynamics Corp., Pomona, Calif. All inquiries relative to subcontracting should be referred to the above company.

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U. S. Army Engineer District, Jacksonville
575 Riverside Avenue
Jacksonville, Fla.

Construction of missile launching facility addition, Cape Canaveral Missile Test Annex, Air Force Missile Test Center, Patrick Air Force Base, Fla. Job—IFB ENG-08-123-63-24B. Bid opening 11-29-62. Payment in advance of $6.00 per set of drawings and specs is required before papers will be furnished. Payment will not be refunded. Approximate cost is $400,000.

# book reviews

PHYSICS IN THE SOVIET UNION—AN EXPOSITION OF THEORETICAL PHYSICS. A. S. Kompanayets. Philosophical Library, New York. 592 pp., $7.50.

This work might well have been called "Theoretical Physics for Engineers and Physicists." It is a contemporary, general discussion of accepted physical theories.

In part one—on mechanics—the author derives Lagrange's equations by transforming Newton's equations through generalized coordinates.

Part two—dealing with electrodynamics—is prefaced by a section wholly devoted to the definition of vector differential operators and proofs of their properties.

Part three of the book treats microscopic analysis of quantum mechanics, and part four discusses statistical thermodynamics.

SPACE MEDICINE, Ursula T. Slager. Prentice-Hall, Inc., Englewood Cliffs, N. J. 388 pp., $12.

A scholarly, readable book concerning many of the basic principles of aerospace medicine. Dr. Slager—associate pathologist at Orange County General Hospital, assistantant clinical professor pathology, University of Southern California, and a consultant on space medicine—takes a realistic approach to her subject. She discusses experimental conditions under which existing knowledge was obtained without generalizing on the data gleaned from man's limited experience in space.

The book is divided into three sections: ecology of space (pressure, temperature and radiation environments); biodynamics of space flight (acceleration and deceleration, weightlessness, noise and vibration); and ecology of space cabins (metabolism, toxicology, psychology). An epilogue briefly deals with the ecology of other planets and interplanetary space.

This is an excellent reference, more for the systems engineer than for the practitioner in aerospace medicine.

THE SHIFT AND SHAPE OF SPECTRAL LINES, Robert G. Breene, Jr. Pergamon Press, New York City. 336 pp., $15.

The problems of the high temperatures of gases surrounding vehicles during reentry call for something new in the way of probes to determine such temperatures and densities. It is as one of these probes that the breadths and shapes of spectral lines are gaining a practical importance.

This book is devoted to the broadening and shift of gaseous spectral lines. It is among the first presentations of material on this subject and covers all recent advances in the field. The material will be of considerable interest to research workers in spectroscopy, astrophysics and astronautics.

MODERN INFRARED TECHNOLOGY, Barron Kemp. Howard W. Sams & Co., Inc., New York City. 255 pp., $4.95.

Written in semi-technical language, this book is designed for the electronic technician, student or experimenter who wants to extend his knowledge of electronics into the field of infrared energy.

Topics include: sources of radiant energy, infrared detectors, infrared imaging devices, optics for infrared systems, remote temperature measurements, spectroscopy and spectrophotometry.

SPACECRAFT THERMODYNAMICS SYMPOSIUM, edited by G. A. Etemad. Holden-Day, Inc., 728 Montgomery St., San Francisco 11, Calif. 175 pp.

Etemad presents six unclassified papers—with a discussion of each—from the Spacecraft Thermodynamics Symposium held March 28, 1962 in Palo Alto, Calif. In their treatment of problems associated with spacecraft thermodynamics, the proceedings stress correlation of actual flight test data with analytical prediction.

The first paper summarizes thermal data accumulated on *Agena* flights, compares the data with predictions and discusses design criteria for laminar-turbulent transition. The second paper reviews parameters affecting the exact location of propellants in the *Agena* tanks under zero-g conditions, discusses venting methods used on various *Agena* vehicles and reports on a current study to determine propellant temperatures and circulation under orbital conditions.

Orbital thermodynamic design of the *Discoverer* vehicle is discussed in the third paper, which compares data received from vehicles in orbit with the prediction methods used. The fourth paper describes experimental determination of thermal radiation properties of temperature control surfaces for spacecraft.

Another paper outlines the effects of spacecraft environment on thermal control materials characteristics; it describes experimental programs to investigate these effects; and it reviews information on thermal control material stability. The final paper discusses design and development of thermal and atmospheric control systems for spacecraft orbiting large primates.

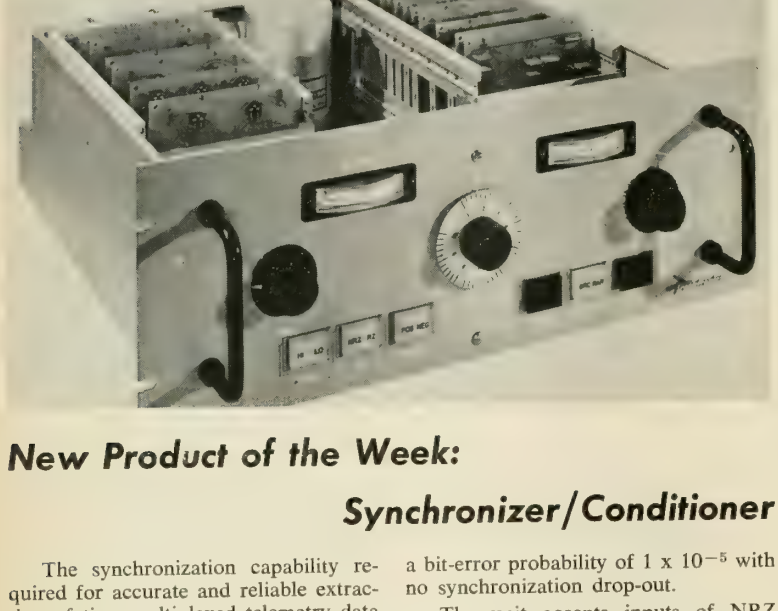
Discussions following each paper provide excellent critical evaluation of thermodynamics problems that are of vital interest to scientists and engineers engaged in various missile/space programs.

DYNAMICS—PARTICLES, RIGID BODIES, Vol. I, R. L. Halfman. Addison-Wesley Publishing Co., Inc., Reading, Mass. 379 pp., $7.50.

Intended as a full-year course in dynamics for engineering students, this volume puts strong emphasis on moving reference frames and observers—and emphasis needed to study the free-body motion of such vehicles as missiles and spacecraft.

The author stresses the relation of dynamics to such neighboring fields as elasticity, thermodynamics and electromagnetism. A practical tack is taken throughout the text.

A good one-year physics course as well as an understanding of differential equations is needed to follow the demonstrations.



## New Product of the Week:

## Synchronizer/Conditioner

The synchronization capability required for accurate and reliable extraction of time-multiplexed telemetry data under very poor noise conditions is available with a new bit synchronizer and signal conditioner developed by Dynatronics, Inc. The Model BSC-1 unit, designed around a highly refined phase-lock loop, can establish and maintain PCM bit synchronization at extremely low signal-to-noise ratios and over wide ranges of bit-rate deviation. At a peak video-rms-noise ratio of 9 db, for example, the BSC-1 provides a bit-error probability of 1 x $10^{-5}$ with no synchronization drop-out.

The unit accepts inputs of NRZ (non-return-to-zero), RZ (return-to-zero), or split-phase PCM code, either positive or negative, at bit-rate ranges between 10 and 640,000 bit/sec and amplitudes between 0.5 and 50 volts peak-to-peak. The dual output consists of four phase-synchronized sequential timing pulses and positive, noise-free NRZ PCM between −12 volts and ground.

Circle No. 225 on Subscriber Service Card

## Beryllium Mirrors

A wide range of beryllium mirrors for use in airborne instrumentation, very precise optical systems and optical test equipment with surfaces that are dimensionally accurate, clean, and completely free from hairline scratches, are available from Precision Lapping Co.

These beryllium mirrors can be lapped and polished to an accuracy of a fraction of a light band, depending on requirements, using specially developed polishing materials and methods. Flat, spherical and aspherical shapes are available.

Circle No. 226 on Subscriber Service Card

## Miniature Gyroscope

A miniature two-degree-of-freedom gyroscope is available from Clary Dynamics Corp.

During sled tests at 350g acceleration, total drift on 12 units averaged 0.7° in 15 sec. In Scorsby 3-axis tests, total drift averages 0.5° in 15 sec.

Gimbal freedom of ±30° is obtained and the 2K potentiometer pick-offs have a functional angle of ±25° on both gimbals. Resolution is 0.2°.

Weight in all configurations is less than 1/16 pound in an envelope 2 in. dia. and 3 in. long.

Circle No. 227 on Subscriber Service Card

## Data Logger

The NLS RS3, a low-cost data logger, is offered by Non-Linear Systems, Inc. The RS3 does not include the digital voltmeter, but any NLS 4-digit voltmeter without printout connection can be used.

The RS3 can accommodate any 5, 6, 7 or 8-channel tape code, and coding can be changed either by shifting diodes on a plug-in circuit board or by interchanging pre-wired plug-in boards. "Word" structure (program) can be changed by rearranging jumpers on an externally accessible plug-in program connector or merely by interchanging pre-wired plug-in connectors. Any of the 20 inputs can be fed directly to the digital voltmeter or automatically routed through an external accessory, such as a preamplifier or an ac/dc converter before reaching the voltmeter input.

Circle No. 228 on Subscriber Service Card

## Bandswitching Discriminator

A bandswitching discriminator, ideal for data reduction, back-up instrumentation, and rapid automatic checkout, is being marketed by Electro-Mechanical Research, Inc. The EMR Model 214 can be switched by push-button or remotely to any FM channel in milliseconds with no loss in performance. Through rapid-channel switching, the unit can be used as a data-reduction discriminator in which a large number of possible channel selector/output filter combinations can be used to advantage in reducing data at low signal-to-noise ratios.

Bandswitching is performed by means of push-buttons which light to indicate the channel selector and LPOF selected. The amplitude of the individual subcarrier at the input can be anywhere within the range of 15 millivolts to 10 volts without adjustment.

Circle No. 229 on Subscriber Service Card

## Diffusion Pump Fluid

A silicone diffusion pump fluid capable of producing ultra-high vacuum without refrigeration has been developed by Dow Corning Corp.

The fluid is capable of producing a vacuum in the range of $10^{-8}$ to $10^{-10}$ torr without refrigeration, and in the range of 5 x $10^{-11}$ when baffles are cooled to −35°C. In addition, the product is chemically inert, nontoxic, clean, and resists gamma radiation.

Typical applications for diffusion pumps using this fluid include vacuum deposition of films in capacitors, transistors, and microminiature assemblies; high altitude-temperature space simulation chambers; optical coatings; unrefrigerated ultra-high surface studies; and vacuum metalizing of plastics.

Circle No. 230 on Subscriber Service Card

## Humidity Transmitter

A humidity-to-air-pressure signal transmitter converts humidity values ranging from 1.6% to 99% relative humidity to a three to 15 psi pneumatic signal for indicating, recording or controlling humidity by means of a pneumatic-type receiver system is available from Hydrodynamics, Inc.

The transmitter produces a no-lag, pneumatic pressure output proportional

to the calibration of the company's precision humidity sensors in the narrow-range, high-resolution model for controlled environments.

A temperature-compensated model is also offered with a pneumatic signal of 3 to 15 psi directly proportional to relative humidity when used with wide-range humidity sensors.

Circle No. 231 on Subscriber Service Card

## Miniature Capacitor

High current, solid-state porcelain capacitors are available from Vitramon, Inc. The units will handle up to 14 amps of current and range from 1 to 2000 pico farads. They permit drastic reduction in the size of equipment, such as transmitters and other applications requiring high current operation.

Operating range is from −55° through 125°C, and from 2 to 30 mc/s the capacitors will operate at 1500 VAC RMS.

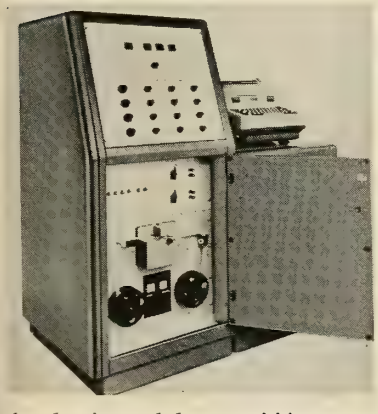
These stable, reliable parts maintain the environmental requirements of MIL-C-11272B and capacitance drift is only .05% or .05 pf, whichever is greater.

Circle No. 232 on Subscriber Service Card

## Low-Cost Computer

A low-cost control computer has been developed by Diginamics Corp. Among features of the computer are a basic memory of 2048—24 bit words including sign, expandable, add-subtract times of 78 microseconds and standard 19-in. relay rack mounting 12¼" high. It is designed for an industrial environment and does not require an air-conditioned room.

It is ideal for medium scale, control,



data logging and data acquisition, automatic component test and calibration, closed loop control and other test stand operations. In addition, it can be used for satellite operation in conjunction with overloaded large-scale computers.

Circle No. 233 on Subscriber Service Card

## Sweep Generator

The Industrial Products Div. of Jerrold Electronics Corp. is marketing a Video-Sweep Generator (Model 1015) covering the 1 kc to 15 mc range for testing the frequency response of crystal filters and similar networks. Three types of output modes are provided: wide sweep, narrow sweep and C.W. The wideband sweep covers the entire range from 10 kc to 15 mc. The narrow-band sweep permits sweep widths from 0 to 400 kc, centered anywhere between 1 kc and 15 mc. Output is maintained at 2.0 volts rms.

The instrument also contains a calibrated output meter and a highly regulated power supply. It is available for either 50-ohm or 75-ohm output impedance and comes equipped with either BNC or N-type fittings.

Circle No. 234 on Subscriber Service Card

## Explosive Bolts

A line of explosive bolts specially designed for use in guided missiles has been developed by Hydro-Space Technology, Inc. The bolts provide instant and reliable launch release and stage separation for rockets. They also can be used in aircraft to provide a positive and dependable means of mechanically securing assemblies such as pilot seats, capsules, fuel tanks or armament and reliably separating them when desired.

In addition to aircraft applications, the bolts also are used in oceanographic applications for separating anchors, ballast, or expended batteries so that research equipment can be recovered for analysis and re-use.

Circle No. 235 on Subscriber Service Card

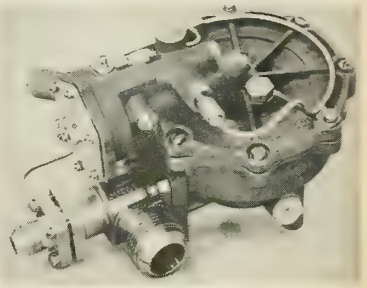
## Microwave Interferometers

MHD Research, Inc. is marketing a series of microwave interferometers for plasma diagnostics. The versatile unit is readily adapted to exploratory diagnostics work on shock tubes, electrical propulsion, gaseous discharges, seeded-combustion product channel flow, plasma jet channel flow, thermonuclear devices, etc. The interferometer produces a stable microwave signal, which is directed along two paths, one through the region that is under investigation and the other a reference path. For increased sensitivity, the signals through the two paths create a null balance in the absence of the test material. Attenuation and phase shifts are then determined by the signals emerging from the path containing the sample medium. Conductivity and dielectric constant may be computed. Using several different test frequencies, the conductivity may then be separated into ionic and electronic components.

Circle No. 236 on Subscriber Service Card

## Helium Pressure Regulator

Helium pressure regulator developed by Telecommunicating Corp. for USAF experimental propulsion system

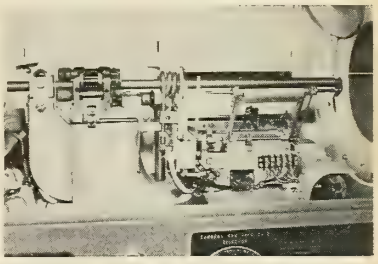


incorporates flight-weight single-stage dome reference design, and can withstand 1000°F temperatures. Toggle mechanism translates actuating force to flow-metering element, which consists of a precision spherical poppet and seat thermally isolated from sensing and translating system. This renders unit insensitive for three minutes to fluid inlet temperatures from —100°F to 1000°F. Regulator can control tank pressure at 28.0 psig at flow rates from zero to 0.07 lbs/sec helium at 1000°F, with inlet pressure decaying from 3500 to 200 psig over an ambient temperature range of —40°F to 165°F.

Circle No. 237 on Subscriber Service Card

## Carbon-Loading System

The means of providing long-period operation of a carbon arc as a light

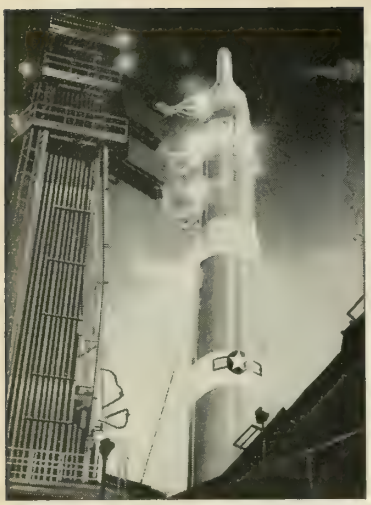


source for simulating solar radiation has been developed by the Strong Electric Corp. The automatic carbon-loading system, whereby the carbon arc lamp is capable of long-period operation without the need of shutting down the lamp to recarbon, is especially important where tests must be conducted for thermal heat balance and material degradation effects.

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## Semi-Portable Computer

A semi-portable vertical dynamic balancing machine and computing system, which translates vibration into corrective balancing data, is available from



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The Titan missile wears a skirt molded of R/M Style 40RPD Pyrotex® felt impregnated with a special heat-resistant phenolic resin.

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Cross section showing exit skirt molded of Prepreg, R/M Style 40RPD Pyrotex® felt.

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The new device detects, isolates, analyzes, and reports vibration caused by unbalance in vertically operated rotating machinery, or components for general industry and aerospace projects.

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## Spectrum Analyzer

The General Applied Science Laboratories, Inc., has available the SA-12A spectrum analyzer. Inputs may be derived from tape as well as in real time. Output information is available in digital and analog form. The system bandwidth extends from virtually dc to 250,000 cps over several scales. The lower frequency scale extends from dc to 5 cps with a 0.01 cps resolution. The form of input is in no way restricted and may include periodic, transient, or random signals.

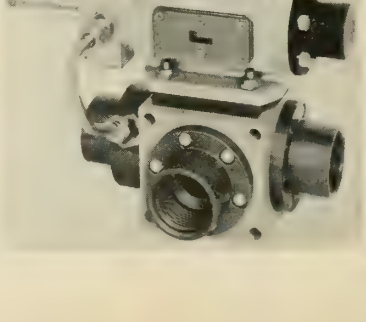
The 3-db resolution is 1/500 of the maximum frequency in each scale. The storage time figures are based on a delay line length of 2000 microseconds, a minimum sampling rate of 4:1 and a total storage capacity of 2000 words.

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## Three-Way Valve

A high-speed and high-pressure three-way ball valve is being marketed in a solenoid-controlled type from Flodyne Controls, Inc.

The valve is designed for applications requiring high-speed directional flow control with a minimum of pressure drop in gas and fluid lines, and zero leakage at 3000 psi.



Major features are operating times of less than 50 milliseconds with valve resetting on de-energizing of solenoid, positive electrical feedback of valve position with visual position indicator.

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# new literature

APPLICATIONS OF SPECTRUM ANALYZER—A free handbook describing applications of spectrum analyzers in telemetry, biological research, measurement of Doppler changes, seismic vibrations and burning stability of rocket fuel has been published by Raytheon Company's industrial components division. Illustrated with photographs, drawings, block diagrams and charts, the eight-page handbook also describes operation and specifications of Raytheon's Rayspan spectrum analyzers.

Circle No. 200 on Subscriber Service Card

CONTROLLED RECTIFIER—A book published by International Rectifier Corp. stresses the importance of the physical properties of controlled rectifiers and their effect in application. The text has been based only on those device characteristics that can be observed and measured. Subjects covered include structure and operation, static characteristics, dynamic characteristics, gate characteristics, thermal characteristics, cooling methods and test procedures.

Circle No. 201 on Subscriber Service Card

CARBON COMPOSITION POTENTIOMETER—Centralab has announced the publication of an eight-page engineering catalog devoted to the Model Two Radiohm (R) potentiometer. This brochure describes all basic variations of this control. Illustrations and detailed dimensional drawings of four terminal types, five mountings, 10 shaft styles, and five switches that can be supplied as standard variations of the Model Two potentiometer are listed. In addition, 26 standard tapers are available.

Circle No. 202 on Subscriber Service Card

ULTRA-HIGH-VACUUM TEST SYSTEM—Features specifications of the Type 1452 test facility, which duplicates outer space altitude and temperature conditions for running long-term evaluating tests on electronic or mechanical components, are covered in four-page Technical Bulletin 1452521 from General Vacuum Corp. The system attains $2 \times 10^{-8}$ torr without heavy baking or metallic gaskets, and can maintain shroud and platen temperatures independently and accurately between −100°F and 250°F.

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# soviet affairs

By Dr. Albert Parry

### High praise for Soviet rocket troops . . .

has for weeks and months filled *Krasnaya Zvezda (Red Star)*. Beginning in October, a note of urgency was sounded in the main organ of the Red armed forces.

The Oct. 7 issue typically front-paged a report from two special correspondents, Majors A. Shichalin and Ye. Udovichenko, at "Rocket Unit X" described as one of "strategic missiles." A photo of a huge rocket accompanied their account of the unit's training exercises. The article stressed the unit's prompt and enthusiastic response to the announcement that the USSR's armed forces were to be brought to "the highest combat readiness." The writers stated that a number of men in the outfit who were near the end of their terms of service filed requests to postpone their release. The rocket unit's training exercise proved remarkably successful, the writers reported, even though it was conducted with incomplete crews: the practice of teaching Soviet rocket men two and three specialties each, instead of just one, has paid off; the men can easily substitute for one another.

### But certain weaknesses . . .

of Red rocket-troop training are being admitted. In its lead editorial of Oct. 23, *Krasnaya Zvezda* criticized Soviet missile-unit commanders who, carried away by their purely administrative tasks, neglect their men's combat readiness, particularly coordination of their individual skills at the launchers.

On the eve of setting out for the launching sites, the article says, these officers find that their troops are not up to handling complex problems. The commanders "cannot see nor wish to see the latest problems brought up by modern war science," *Red Star* declares. They have grown soft; "having become accustomed to act under easy conditions, they are reluctant to make their troops' training assignments more complex."

### Some rocket officers are chided . . .

for unwillingness to train their subordinates. In *Krasnaya Zvezda* of Sept. 21, Senior Lt. L. Yegorov castigates colleagues who deliver lectures to gatherings of a score or more missile soldiers rather than bother with individual training. Yet, the indignant lieutenant points out, in many a rocket unit "an officer often has under his immediate command no more than one or two soldiers," and the job of insructing them in handling rocket machinery is easy and not at all "dirty," although, of course, "to convince or teach one man is harder than to lecture 20 or 30 troopers at once."

### Young soldiers are sometimes barred . . .

from handling rockets even if they joined these missile units after proper training. A Sept. 20 *Krasnaya Zvezda* editorial on this subject complains that certain rocket officers are afraid to trust fresh recruits with complicated mechansims "lest the young expert botches the entire operation." But if they are deprived of practice, it notes, "how will the young warrior become an experienced specialist?" Other rocket commanders, the editorial reports, are too timid even with good troops at their disposal. One Soviet missile officer habitually halts his unit's training when night falls.

"But will a real enemy under the circumstances of a real battle extend to him the courtesy of such an intermission?" asks *Krasnaya Zvezda*. And then there is the rocket supply officials' over-thrifty reluctance to furnish missile troops with enough material for target practice. "We are greatly surprised by this unwillingness," laments a captain of the Soviet navy, describing the trials as well as triumphs of Red missile-armed boats in *Krasnaya Zvezda* of Oct. 2.


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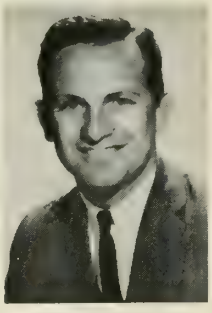
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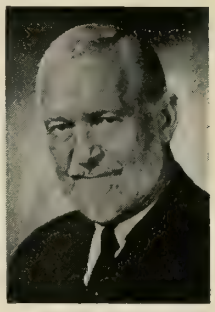
# names in the news


KAHN


WAITLEY


DUFF


WILSON


PIRIE

**K. Robert Kahn:** Named corporate vice president, Lear Siegler, Inc., Los Angeles.

**Denis E. Waitley:** Appointed manager of advertising and public relations for Electronic Speciality Co., Los Angeles.

**Victor E. Matulaitis:** Appointed senior research and development engineer at Ex-Cell-O, Detroit.

**Joseph M. Walsh:** President of the Instrument Div. of Lear Siegler, Inc., Grand Rapids, Mich., named a corporate vice president.

**Ed C. Nikkel:** Named manager of contract administration and weapons system manager of Beech Aircraft Corp., Wichita, Kan.

**A. M. Okun:** Appointed corporate director of reliability for General Instrument Corp., Newark, N.J.

**Fred F. Willis:** Appointed program director, subcontracts, at the Aircraft-Missiles Div. of Fairchild Stratos, Hagerstown, Md.

**Robert W. Tharrington:** Named vice president-general manager of the Boeing Co.'s Vertol Div., Morton, Pa.

**Dr. Robert S. Carlson:** Appointed director of engineering at Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif. **James C. Elms** appointed director of space and electronics. **Charles H. Sword** appointed manager of the contract administration office.

**James E. Duff:** Elected vice president of Alsop Engineering Co., Milldale, Conn.

**Dr. Charles Carroll:** Selected to head a group of senior scientists and engineers who will serve on a Range Development Technical Staff at the Atlantic Missile Range. Also serving are **Dr. H. H. Germond, Dr. Samuel Burkett** and **Dr. Paul Broome.**

**Earl Gregory:** Named *Minuteman* program manager for Raytheon Co.'s Semiconductor Div., Mountain View, Calif.

**Richard A. Wilson:** Appointed vice president and general manager of General Dynamics/Electronics, Rochester, N.Y.

**Bliss M. Bushman:** Appointed vice president-engineering at Consolidated Systems Corp., Monrovia, Calif.

**Alan B. Dallas:** Appointed vice president-field engineering for Minneapolis-Honeywell's Military Products group, Minneapolis.

**R. L. Halpern:** Appointed director of electronic systems at the Ventura Div., of Northrop Corp., Ventura, Calif.

**Roy A. Lindberg:** Elected chairman of the board of Lindberg Engineering Co., Chicago.

**William H. Gable:** Appointed director of engineering of Aircraft Armaments, Inc., Cockeysville, Md.

**Lawrence J. Torn:** Appointed a vice president of the Data Systems Div. of Harman-Kardon, Inc., Plainview, N.Y.

**Eugene A. Holmes III:** Appointed vice president and general manager of the Semiconductor Div. of Hoffman Electronics Corp., Los Angeles.

**Vice Adm. Robert B. Pirie (USN-Ret.):** Joined Aerojet-General Corp., Azusa, Calif., as executive assistant to the president.

**Dr. Bernard Levine:** Named manager of applications at Martin Co.'s Space Systems Div., Baltimore.

**Ivan J. Dornbush:** Elected president of Technology Instrument Corp. of California, Newbury Park, Calif.

**Rear Adm. Norman Farquhar Garton (USN-Ret.):** Elected vice president of Greer Hydraulics, Inc., Los Angeles.

**Leland H. Frandsen:** Appointed assistant secretary of Consolidated Electrodynamics Corp., Pasadena, Calif.

**Alexander Matiuk:** Appointed vice president-engineering of Gibbs & Hill, Inc., New York City.

**M. R. Collins, Jr.:** Named manager of Lockheed Missiles & Space Co.'s Space Systems Div., Sunnyvale, Calif.

**Robert W. Stieg:** Named chief engineer at FWD Corp., Clintonville, Wis.

**Dr. William E. Shoupp:** Elected vice president and general manager of Westinghouse Research Laboratories, Pittsburgh.

**Dr. Sidney Krasik** elected vice president and general manager of the Astronuclear Laboratory, Westinghouse Electric Corp.

**Daniel W. Bender:** Named manager of the district marketing office of General Precision's Librascope Div., San Francisco.

**Thomas A. Callaghan, Jr.:** Appointed international programs manager for the Aeronutronic Div. of Ford Motor Co., Washington.

**Ernest Stearn:** Named vice president and director of microwave research at Microwave Chemicals Laboratory, Inc., New York City.

**Paul H. Crago:** Appointed chief engineer of the Controls Div., Elgin National Watch Co., Burbank, Calif.

**Robert C. Clouse:** Appointed manager of government sales for Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio.

**Neal Diepeveen:** Appointed engineering manager for Kaiser Electronics, Inc., Union, N.J.

**Dr. Hal Ellis:** Appointed manager of Marquardt Corp.'s newly created Reliability and Product Integrity Dept., Power Systems Div., Van Nuys, Calif.

**Richard J. Flynn:** Appointed vice president and assistant to the president of Ling-Temco-Vought, Inc., Dallas, Tex.

**Mark P. White:** Appointed chief engineer of the Electronics Div. of Anderson Laboratories, Inc., West Hartford, Conn.

**Robert F. Frost:** Appointed director of engineering of Welex Electronics Corp., Washington, D.C.

**Dr. William C. Hunt:** Appointed manager of laboratory facilities of the central research laboratories of Celanese Corp. of America, Summit, N.J.

**Herbert Harris, Jr.:** Appointed director of engineering for Sperry Gyroscope Co., Great Neck, N.Y.

**Lt. Col. James L. Farmer (USA ret.):** Named senior representative for Army programs of the Motorola Military Electronics Div., Scottsdale, Ariz.

**James W. Dunham:** Appointed director of advanced missile systems at Northrop Norair Div. of Northrop Corp., Hawthorne, Calif.

**Dr. M. Gali Sanchez:** Appointed director of inorganic research for W. R. Grace Corp.'s Washington Research Center, Washington, D.C.

**Daniel R. Fisher:** Appointed assistant manager, Surface Armament Div. of Sperry Gyroscope Co., Great Neck, N.Y.

# when and where

## NOVEMBER

**Mid-America Electronics Conference, IRE,** Hotel Continental, Kansas City, Mo., Nov. 19-20.

**Twelfth Semi-Annual Meeting and Mid-year Conference of the Manufacturing Chemists' Assn.,** Commodore Hotel, New York City, Nov. 20.

**ASME Winter Annual Meeting,** Statler Hilton Hotel, New York City, Nov. 25-30.

**Western States Section Meeting, The Combustion Institute,** Aerojet-General Corp., Sacramento, Calif., Nov. 26-27.

**Annual Coordinated Meetings: American Nuclear Society, Atomic Industrial Forum and joint Atom Fair,** Sheraton-Park and Shoreham Hotels, Washington, D.C., Nov. 26-28.

**American Institute of Electrical Engineers, Machine Tools Conference,** Statler Hilton Hotel, Detroit, Nov. 26-28.

**Environmental Testing Seminar, sponsored by Gulton Industries, Inc.,** Metuchen, N.J., Nov. 26-30.

**Radio Technical Commission for Aeronautics, Fall Meeting,** Marriott Motor Hotel, Washington, D.C., Nov. 27-29.

**1962 Ultrasonics Symposium, IRE,** Columbia University, New York City, Nov. 28-30.

**Human Factors Society Annual Meeting,** Barbizon-Plaza Hotel, New York City, Nov. 28-30.

## DECEMBER

**Fall Joint Computer Conference, sponsored by American Federation of Information Processing Societies and IRE,** Sheraton Hotel, Philadelphia, Dec. 4-6.

**Vehicular Communications Conference, IRE,** Disneyland Motel, Los Angeles, Dec. 6-7.

**First Annual Symposium on Unconventional Inertial Sensors,** Republic Aviation Corp.'s Paul Moore Research & Development Center, Farmingdale, N.Y., Dec. 10-11 (classified).

**Pricing and Negotiating Prime and Subcontracts in the Defense and Aerospace Industries Seminar,** Marriott Motor Hotel, Washington, D.C., Dec. 10-14.

**Structural Dynamics Under High Impulse Loading Symposium, sponsored by AFOSR (Mechanics Div.) and Aeronautical Systems Div.,** Wright-Patterson Air Force Base, Ohio, Dec. 17-18.

**Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science,** Philadelphia, Dec. 26-31.

**American Astronautical Society Symposium on Scientific Satellites-Mission and Design,** Franklin Hall, Philadelphia, Dec. 27.

## JANUARY

**Millimeter and Submillimeter Conference, IRE,** Cherry Plaza Hotel, Orlando, Fla., Jan. 7-10.

**American Chemical Society National Meeting,** Cincinnati, Ohio, Jan. 13-18.

**Automotive Engineering Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Mich., Jan. 14-18.

**Ninth Annual American Astronautical Society Meeting,** Statler Hilton Hotel, Los Angeles, Jan. 15-17.

**31st Annual Meeting, Institute of the Aerospace Sciences,** Hotel Astor, New York City, Jan. 21-23.

**43rd Annual Meeting, American Meteorological Society,** New York City, Jan. 21-24.

**Ninth National Symposium on Reliability and Quality Control,** Sheraton-Palace Hotel, San Francisco, Calif., Jan. 22-24.

**Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn.,** International Inn, Washington, D.C., Jan. 28.

**Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and the Franklin Institute,** Philadelphia, Jan. 30-Feb. 1.

## FEBRUARY

**Symposium on Engineering for Major Scientific Programs,** Georgia Institute of Technology, Atlanta, Feb. 5-6.

**Electronic Sales-Marketing Assn., First Annual Convention,** Americana Hotel, New York City, Feb. 11-13.

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# ARS Outdoes Itself

SOMETIMES, everything seems to go just right. Such was the case last week for the American Rocket Society. Its 17th Annual Meeting and Space Flight Exposition in Los Angeles was a rousing success.

From the moment a signal flashed from *Mariner II* to open the exposition, it was apparent that the last ARS show was going to be the best. Even the returns on the ARS-IAS election carried good news—merger into the American Institute of Aeronautics and Astronautics seemed assured by an overwhelming majority.

But the new AIAA will have to go some to top the final show of the ARS.

This year's exhibition in Pan Pacific Auditorium, definitely smaller than the mammoth show held last year in the New York Coliseum, was better planned and, without question, more useful technically for those attending.

Almost every stand was packed with technical exhibits, demonstration models and explanatory material. We did not visit a single major stand where there were not well qualified engineers on hand to discuss the products.

Non-technical displays were at a minimum.

Lectures were scheduled frequently throughout each day. One could listen to a Grumman engineer discuss lunar craft with the aid of a working model or learn some of the finer points of ruby lasers from a Hughes scientist.

The Bendix stand seemed almost more of a classroom than a trade show display.

This is not to say that the exhibition was dull—far from it. There was a liveliness to it that was heightened by the fact that it spilled over from the main auditorium into a circus tent annex. It was, to be quite honest, fun.

For the ARS to have achieved this blend of technical usefulness and lively interest is indeed an accomplishment. The industry firms which took part in the exhibition are to be complimented for the care which went into the displays.

A tour of the sprawling exhibition overwhelmed visitors with the breadth and complexity of the U.S. space effort:

• Dominating the big tent annex was the huge Hercules Powder Co. filament-wound motor case—large enough to hold a walk-in technical demonstration inside. It took 23 days to truck the case from the Hercules Rocky Hill, N.J., plant to Los Angeles. From the trek, the company gained valuable experience in moving large motor cases across country. For those who remained unimpressed with the 156-inch size of the case, Hercules engineers were on hand with the reminder that it was wrapped with 240 million miles of filament.

• Behind the Hercules exhibit was what appeared to be a red golf cart chugging around in a circle with two gentlemen aboard. This was no ordinary golf cart. It was powered by a 3-KW Allis Chalmers fuel cell.

• An area screened off by canvas concealed a press conference in which Space Technology Labs was explaining the "world's smallest satellite."

• Nearby, Lear Siegler was preparing for a demonstration of laser welding and a showing of the first production model for its vacuum method of microcircuitry deposition.

• A U.S. Air Force display emphasized advanced concepts for manned and unmanned satellite interceptors, aerospace plane and communications satellites to implement military command and control.

• In a meeting room adjacent to the exhibit area, an engineer explained to a technical session the performance characteristics of a system for television broadcasting by satellites.

• Three huge helium-filled balloons were employed by Douglas Aircraft to lift volunteer "astronauts" off the floor in a weight-reduction demonstration of some of the difficulties of working in a space environment.

• A Marquardt working model clearly demonstrated how the lunar module will ascend from the Moon's surface to rendezvous with the *Apollo* spacecraft orbiting overhead.

A taped voice explained the reaction control rocket engines of the service module: "The rocket engines combine three major elements—a fuel injection system, solenoid valves, and the thrust chamber —molybdenum-coated to withstand a 3000-degree operating temperature. Designed for radiation cooling, the engines will be mounted in outboard clusters of four at 90-degree intervals around the service module exterior. During operation, they will use hypergolic bipropellant fuel to produce . . ."

Outside the auditorium, full-scale boilerplate models of the North American *Apollo* command and service modules emphasized how close to reality Marquardt's theoretical demonstration was coming.

THE SHOW throughout was an impressive demonstration of the vast technical effort the industry-government team is pouring into the U.S. space flight programs. The Rocket Society in its last effort under the ARS banner has left a magnificent challenge for the AIAA in a job well done.

**William J. Coughlin**



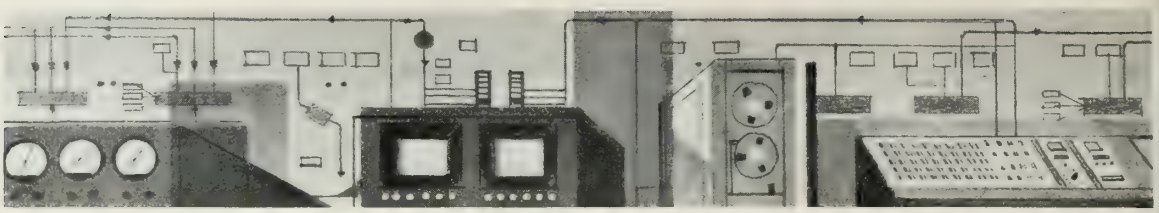
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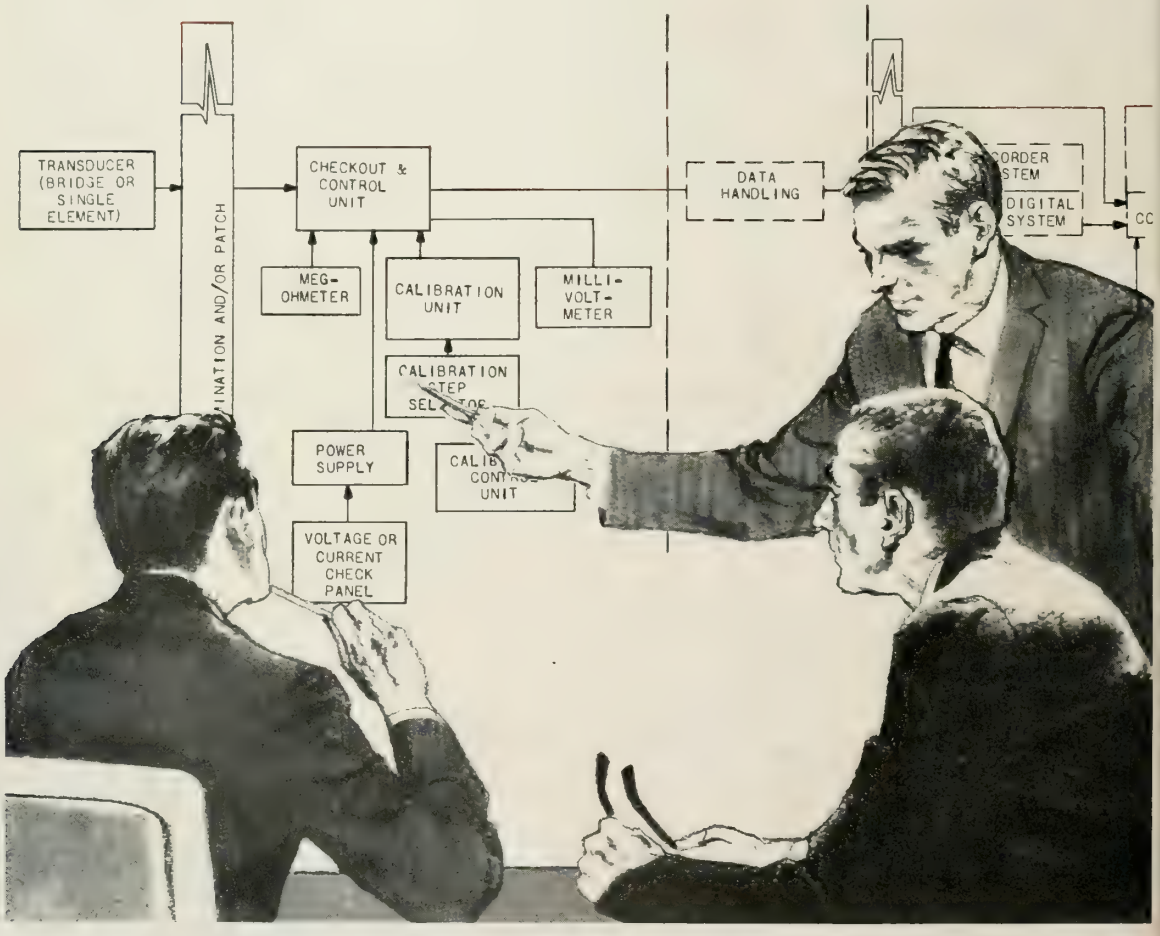
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*This classic phrase was struck by President John F. Kennedy February 20, 1962, in his remarks over television welcoming Astronaut John H. Glenn, Jr., back to Earth.

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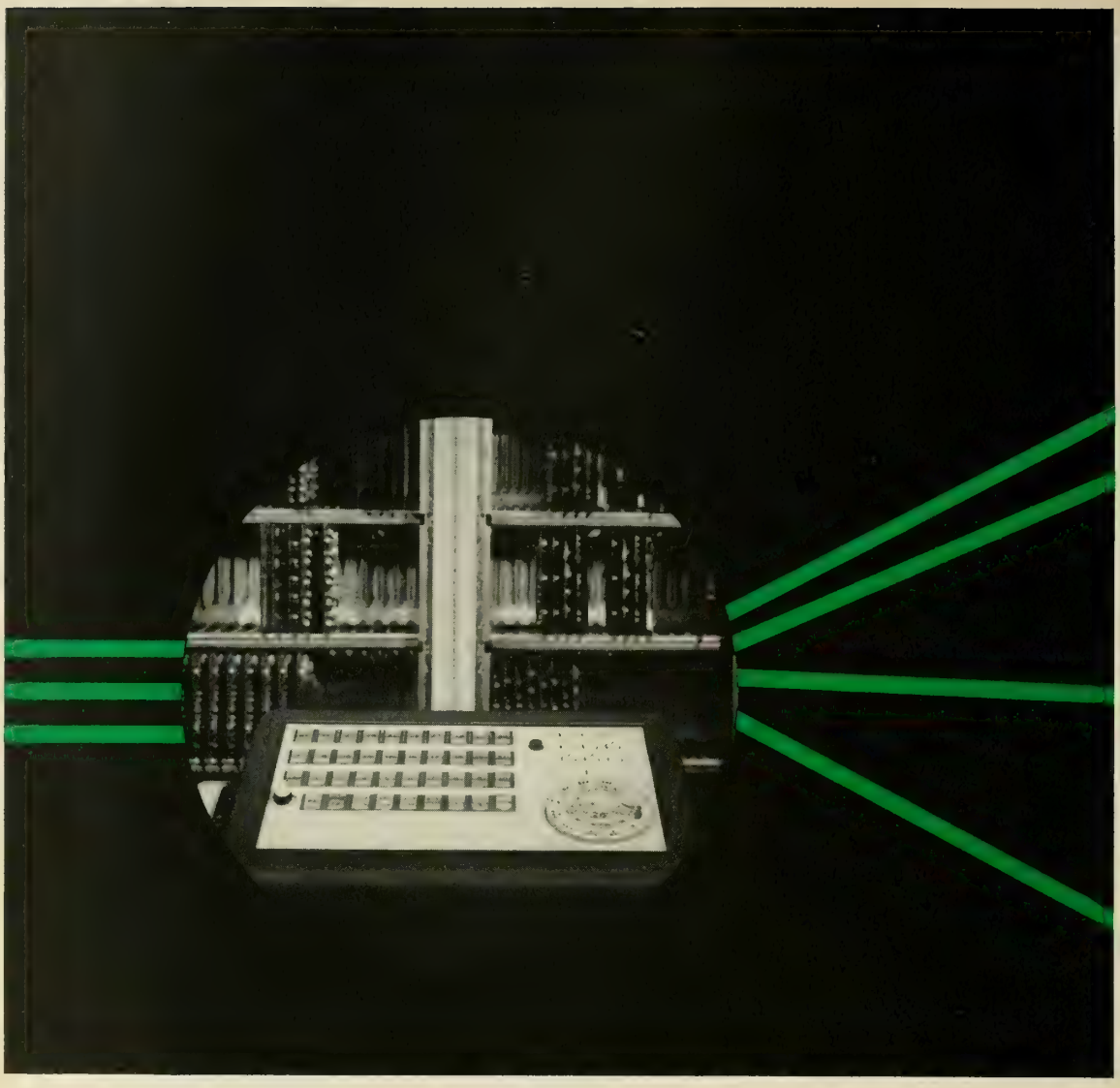
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 22 November 26, 1962

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## THE COVER

*Mercury-Atlas orbital launching shown here in McDonnell Aircraft Corp. photo represents steady progress in U.S. space program.* MISSILES AND ROCKETS' *Second Annual NASA Report starts on p. 39.*

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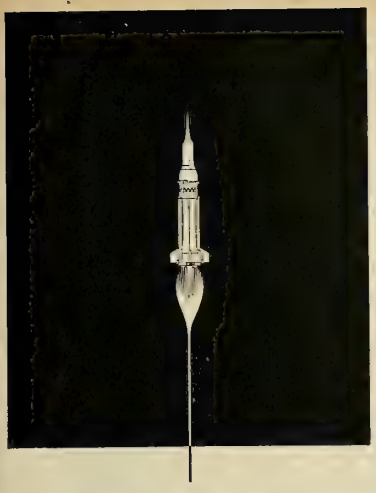
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# letters

## The Ethics of Fame

*To the Editor:*

I've just read with a great deal of interest your Nov. 5 editorial, "The Ethics of Fame."

Permit me to take my hat off to you. Your editorial says a lot of things that have needed saying. I've read quite a few editorials on the subject but none that could hold a candle to yours.

M. B. Schnapper
Editor
Public Affairs Press
Washington, D. C.

*To the Editor:*

It is unique to be able to focus one virtuous eye upon the astronauts and one benevolent eye upon the space industry while talking about ethics out of both sides of your mouth. There is yet humor in the world.

Richard B. Monroe
Oxford, Ohio

*To the Editor:*

You are so pure! Your editorial is enough to make all who are struggling to conquer the unknowns of spaceflight slam down their slide rules and screwdrivers in nauseated disgust. Who has a better right to the financial benefits obtained from their space efforts than our atsronauts—some Hollywood movie tycoon?

The conquest of space has often been compared to the discovery of the Americas by Columbus. Before Columbus set sail he demanded to be made admiral of all the islands, seas, and continents that he might discover and a tenth of all the precious metals discovered within his admiralty. Our astronauts made no such requests.

When Columbus discovered the Americas he was awarded by his government, among other things, one eighth of the gross and one tenth of the net profit of each voyage to the Americas. Our astronauts received no such financial benefits from the government for their extremely hazardous space flights.

Yet, when the exploits of Columbus became unpopular with the ruling powers of his government, he was disgraced and thrown into prison. In this country there are some who are so opposed to our space program that they too would, if they had the power, will a similar fate on our courageous astronauts.

The objectives of most ambitious men, and commendably so, is to obtain and enjoy for themselves and their families the better things in life. When through estimable hard work under hazardous conditions, the likes of which have never been encountered before, our astronauts obtain some semblance of financial achievements, I think they should be pointed to with pride and not cynical criticism.

I for one have enjoyed vicariously many of the heartaching disappointments and thrilling successes of our astronauts. I am very happy to see that from their efforts to resolve the problems of interplanetary travel they are obtaining some of the wealth of this planet.

However, since we all have a difference of opinion now and then I think you should be allowed to express your philosophy on this subject no matter how much controversy it may create.

D. R. Bross
Canoga Park, Calif.

*To the Editor:*

You say our astronauts have shown a lack of character and have failed in honor and reputation. The reason for this you say is that they are profiting on their fame. As any red-blooded ancient philosopher would clearly state, no men of Homeric stature who are leaders and advisors in matters of honor in the best classical tradition would ever do such a deplorable thing or even consider doing it. Well sir, I cannot seem to agree with you, and furthermore feel that someone should state another side, to this picture. This opinion, although it may not even be in agreement with the astronauts, for they may agree with you for all I know, should be voiced once and for all. . . .

First of all, why should an astronaut be asked to remain in such a high state of dignity with an untouchable stature high upon a pedestal? True, the astronauts are figureheads, symbols of great American advancements in science, and should conduct themselves accordingly. But should they live out their lives in a fishbowl, secluded from the materialistic?

We all want to read stories about the astronauts, about their wives, about their children, etc.; therefore, should they just give their stories to *LIFE* or another magazine for nothing? Donating all this money away to some scholarship fund, charity, etc., would be a quite illogical and senseless alternative. It would not be in the best interests of themselves or their families, since they are not in a high income bracket to begin with. . . .

All our great and notable scientists, from Von Braun down, are considered fortunate when their salaries are $20-$25,000 a year. But in this same society we find movie stars and other entertainers who earn $20,000 a month or more. . . .

I do not think any legitimate acceptance of income by the astronauts downgrades their character, but in fact shows the world that in our wild, carefree, moneyrich society some of the just still get their well-deserved share.

Edward W. Wooddell
Wright-Patterson AFB, Ohio

*To the Editor:*

Your courage in saying what needed saying has not gone unnoticed.

Of course, as you quoted Seneca, "The reward of a thing well done is to have done it."

G. M. LeFave
Whittier, Calif.

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*Manufacturing OGO is one of STL's 63 NASA projects since 1960. Current NASA projects range from manufacture of space hardware to studies of spacecraft systems, including the Lunar Logistics System Spacecraft Bus.*

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# The Countdown

## WASHINGTON

### SPRINT Contract Award Expected Soon

Announcement of a contract for development of the *SPRINT* high-acceleration antimissile missile is expected by mid-December. Front-runner is Douglas Aircraft. *SPRINT* is designed to counter re-entry vehicles lower in their trajectory than *Nike-Zeus*, enabling the system to handle more targets per battery. The missile reportedly will be able to accelerate to Mach 6 in 30 sec.

### NASA Budget Fight Heats Up

If not solved, NASA's intra-agency financial dispute will break into the open at upcoming Congressional hearings on the FY '64 budget. Some officials are threatening privately to take their case for more money to Congress if top management turns them down. Not only is there dissatisfaction with the amount of money being set aside for manned spaceflight, but officials in the space sciences are irritated at loss of money to other projects.

### Tales of the South Pacific

Dept. of Defense officials won't comment, but reports of failures in the *Nike-Zeus* program at Kwajalein are true. Two planned intercepts failed due to electronic difficulties and a third was aborted when the *Atlas* target vehicle did not cover the full distance to the intercept point.

### Radiation Belt Is Decaying

Experts now believe the artificial radiation belt created by the July 9 U.S. high-altitude nuclear test will have dissipated by next summer.

### Special Report on Ranger Due Soon

A special NASA committee probing five consecutive failures in the *Ranger* program is expected to submit its report to top officials in about three weeks. Cancellation of the program does not appear to be in the cards. But the committee of technical experts is expected to recommend improvements to the spacecraft.

### Third Saturn Stage Under Study

NASA's decision on a third stage for the *Saturn C-1* booster will be made by the Office of Space Sciences. Its unmanned scientific, lunar and interplanetary spacecraft currently are the only ones requiring a three-stage vehicle. Both *Agena* and *Centaur* are under consideration.

### No Market for Used Mercuries

A plan to use refurbished *Mercury* capsules as rendezvous targets in the *Gemini* program has been rejected by NASA in its current program re-evaluation. Reason: space agency officials regarded the solution as too complex.

### Battalions to Get Davy Crocketts

Under the current Army reorganization, each battalion will be equipped with three *Davy Crockett* nuclear weapons and three *ENTAC* antitank missile squads.

## INDUSTRY

### Pentagon Statement Is Shocker

Industry officials are shocked by the vehemence of the Pentagon statement attacking Lockheed Aircraft Corp. for its refusal to knuckle under to demands for a union shop vote. The threat to shift programs elsewhere and to place the blame for any strike directly on management is unequalled in DOD-industry relations.

### Site Sought for RIFT

The government-owned Michoud plant near New Orleans has been ruled out as a site for manufacture of the *RIFT* nuclear rocket stage. Most likely: a West Coast location although an area near Michoud still is under consideration. Decision is being left to Lockheed by NASA. Incidentally, Boeing and Chrysler, both engaged in *Saturn* booster manufacture at the Michoud plant, are planning additional facilities there.

## INTERNATIONAL

### Soviet ICBM Count Set at 75

Latest estimate by London's highly-regarded Institute for Strategic Studies places the number of Russian ICBM's at 75. Soviet MRBM's are believed to total 700. The Institute says a more accurate second-generation Russian ICBM will be deployed next year. It also credits the Soviet missiles with the ability to carry larger nuclear warheads than their U.S. counterparts.

### More Soviet Missiles in Cuba?

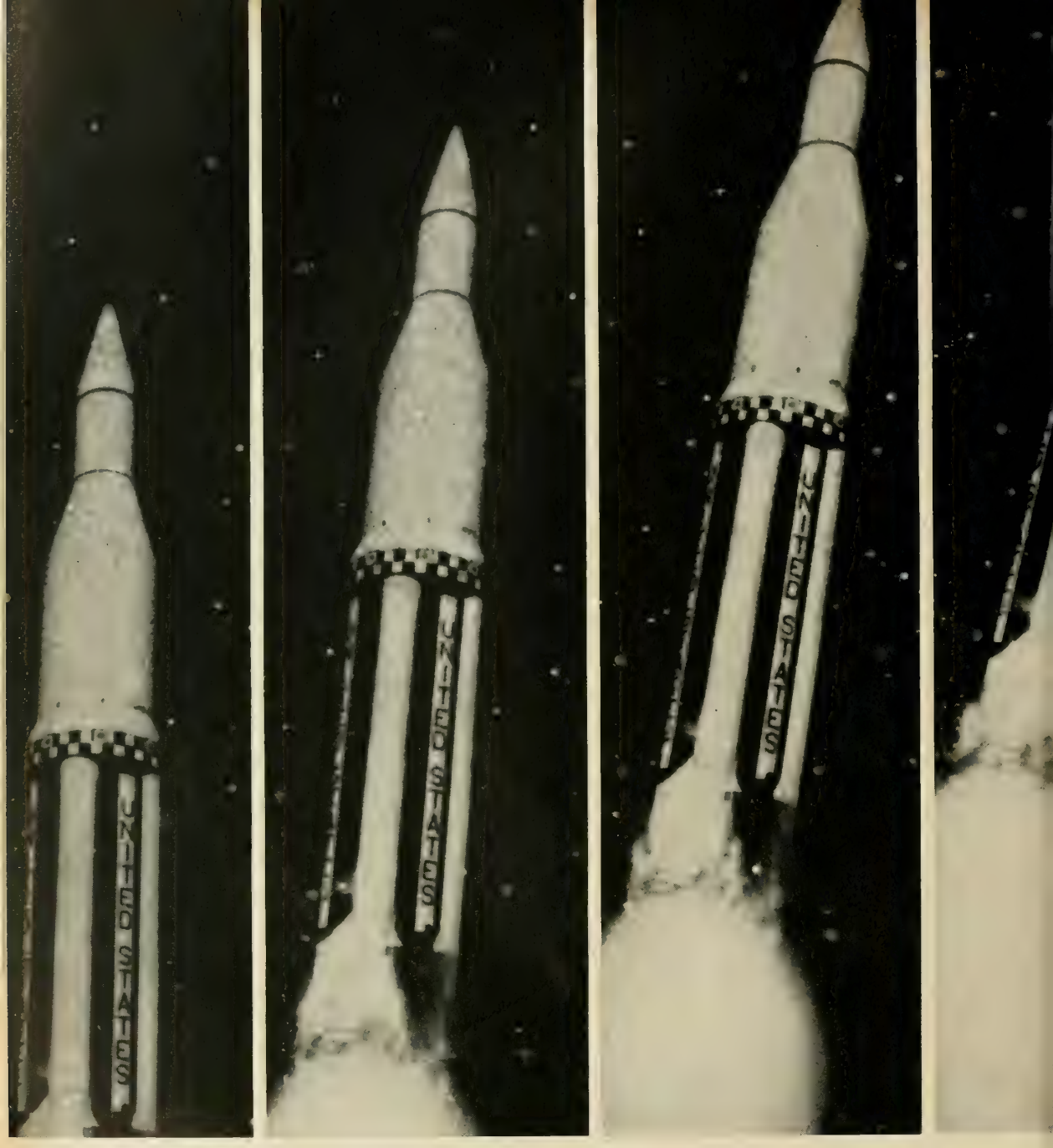
Reports from the Pentagon say Soviet nuclear ground-to-ground missiles with a 25-mi. range have been spotted in Cuba. These tactical weapons can be regarded as defensive but offer a threat to the Guantanamo base.

### Germans Plan Space Science Program

Germany's Aerospace Industries Assn. has outlined a four-year $233-million space sciences program aimed at making that nation a leader in the space field. Some $46 million would be spent for research, with $187 million going to German industry in the form of hardware contracts. Government sources regard the plan as too ambitious.

### British Device Built for Ranger

A neutron generator the size of a teacup has been developed by Plessey Co., Vicarage Lane, Ilford, Essex, England, for the *Ranger VI* Moon probe. It will be used to analyze the lunar surface. Advantage over similar U.S. equipment: it produces a beam of neutrons rather than emitting them in all directions. The device is capable of detecting 57 elements.




# TARGET INSTINCT...

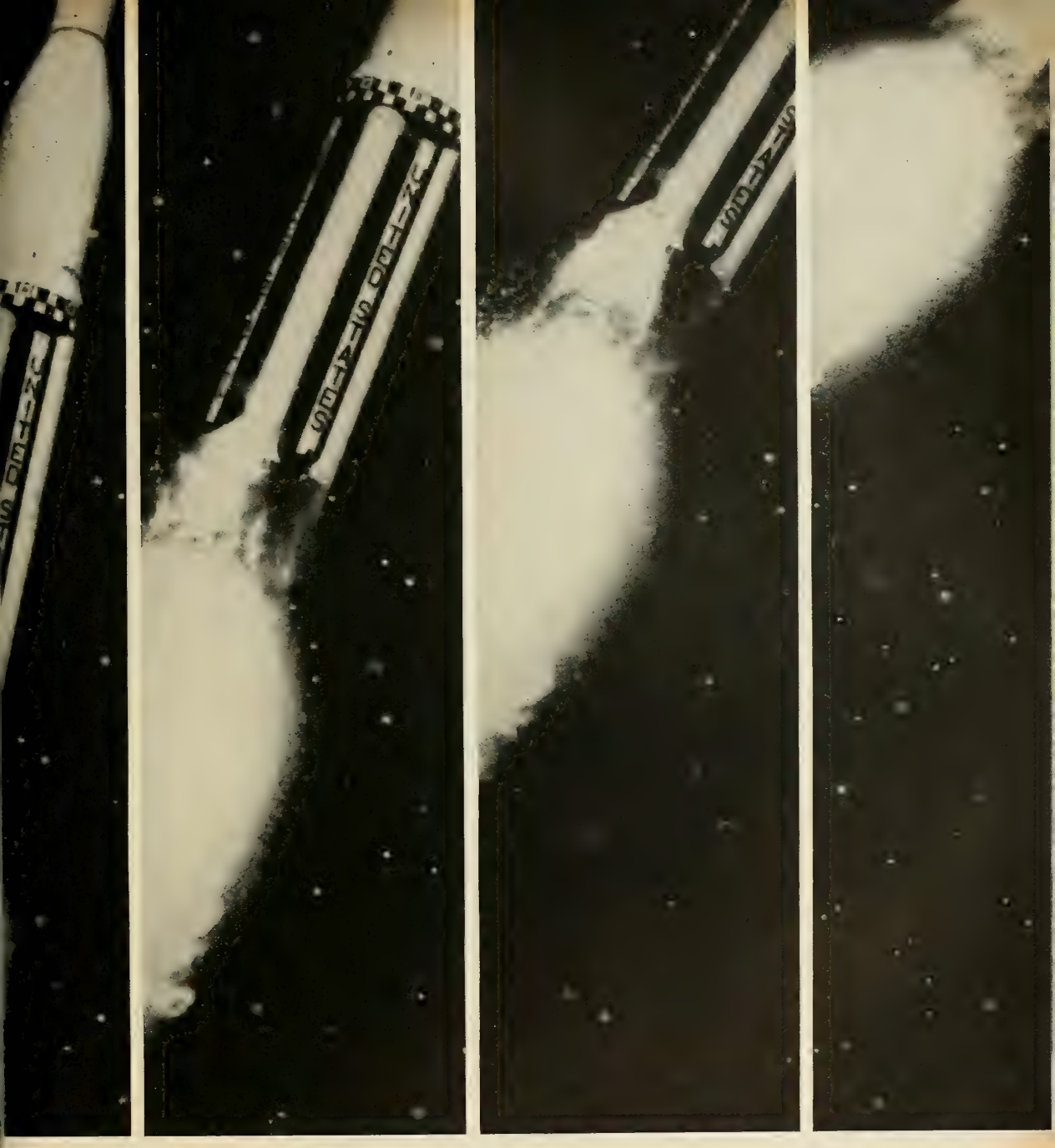
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# Next Saturn Shot Still Due in Spring

CAPE CANAVERAL—A letter-perfect flight by the third *C-1 Saturn* on Nov. 16 is not expected to substantially speed up the rocket's test or development program.

Marshall Space Flight Center officials said at a post-flight press conference the fourth *Saturn* will not be launched until next spring—despite the fact it probably could be scheduled for an earlier date.

Dr. Wernher von Braun, MSFC director, said *SA-3* moved more smoothly through assembly, quality control, shipment to Cape Canaveral and final prelaunch checkouts than the two earlier *Saturns*.

"There was a slack in the schedule which will not be needed in the future," Von Braun said.

He added that the shortened time for preparing *Saturn* test vehicles could not speed the program because the Block II vehicles are not ready for testing.

Von Braun said the Douglas-built *S-IV* second stage of the Block II vehicles is a "bottleneck" in the *Saturn* project. He quickly added that he used the term "bottleneck" to mean the next step in engineering development of *Saturn* components —not a slowdown in the program.

• **Five hundred tons plus**—The *SA-3* vehicle went through a routine and uneventful 10-hour countdown, but missed its scheduled noon launch time by 45 minutes.

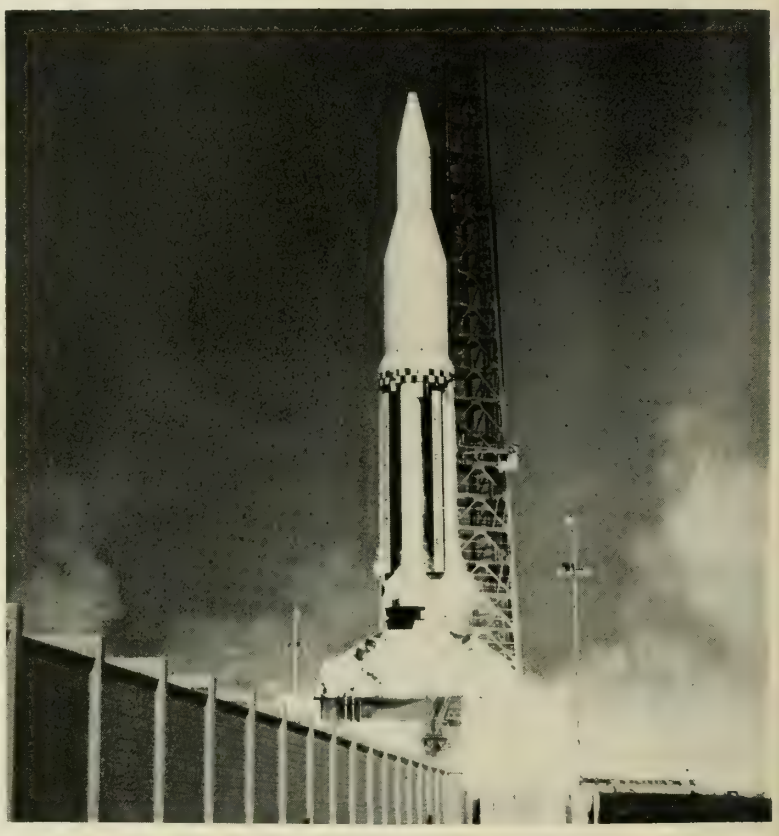
The delay was caused by a defective generator in the ground-support equipment. The repair itself was rapid, but most of the lost time was consumed in removing and replacing a protective cover of sandbags.

The vehicle, largest ever launched in the United States, weighed 1,102,000 lbs. before ignition and 1,086,000 lbs. at liftoff.

The huge weight included 750,000 lbs. of propellant kerosene and liquid oxygen, 130,000 lbs. more than the fuel carried on *SA-1* and *SA-2*

Robert Lindstrom, *C-1* project officer at Marshall, said in a preflight briefing the 620,000-lb. loads on the first two *Saturn* launches permitted flight profiles closely simulating those of the Block II *Saturn* vehicles.

The vast amount of fuel carried by *SA-3* simulated the load of the later *C-1* vehicles, which will be equipped with larger engines generating 188,000 lbs. of thrust.



*SATURN SA-3 shown at liftoff Nov. 16. It was the vehicle's third straight success.*

*SA-3* lifted very slowly from the pad and traveled only 300 feet during the first 10 seconds of flight. All eight of the 165,000-pound thrust engines performed as programed. The four inboard engines cut off at 141 sec. and the four outboard engines burned out eight sec. later.

Four retro-rockets were test-fired on schedule at 152 seconds, but MSFC spokesmen said they had little effect on the flight because their mission is to slow a detached and empty first stage. No attempt was made to separate the empty first stage of *SA-3* from the heavy upper portions of the rocket.

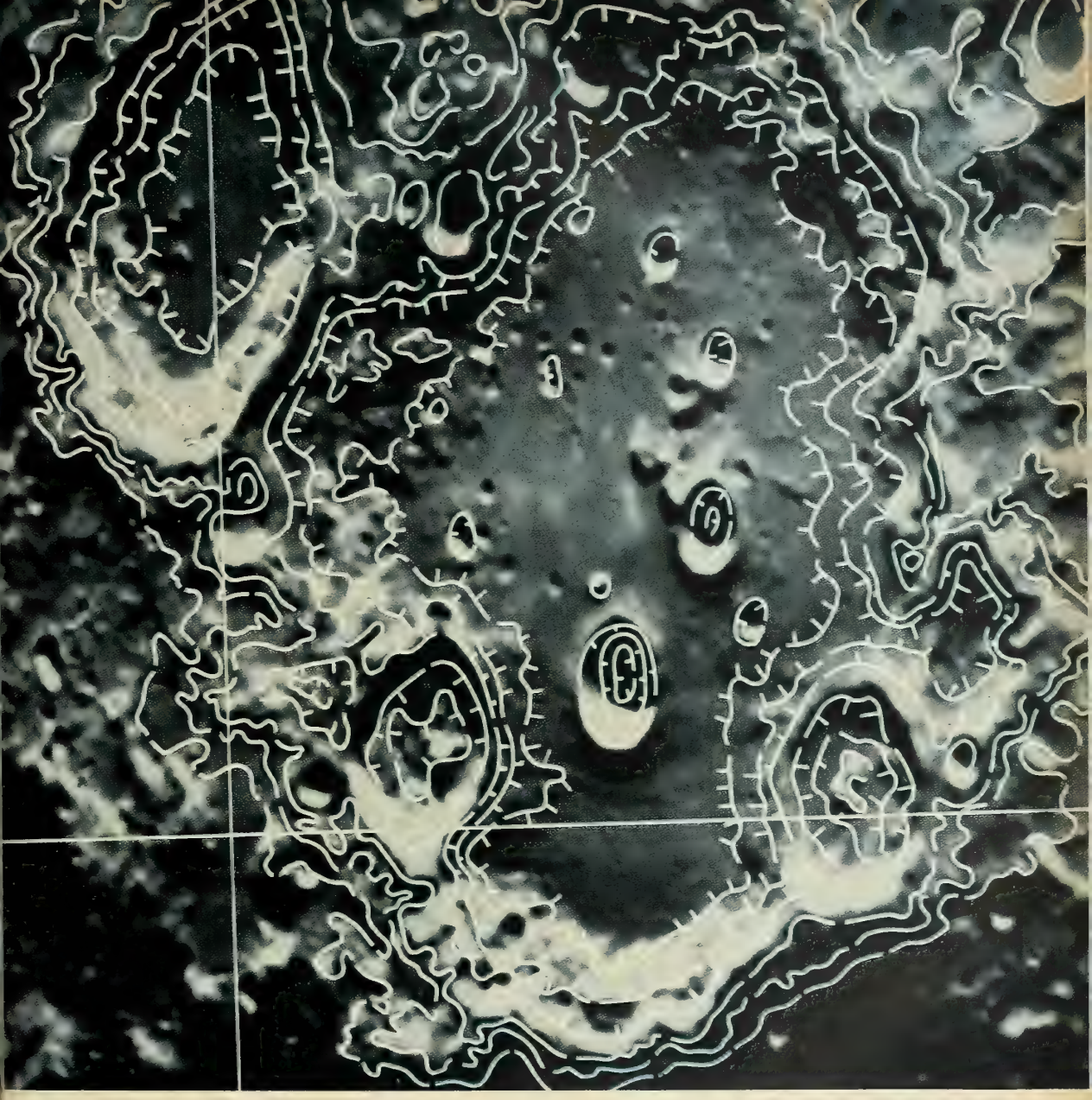
The rocket coasted to 104 miles altitude where it was destroyed by a primacord blast at 292 seconds. The explosion ripped the upper stage tanks apart and released 95 tons of water ballast into the rarified atmosphere, forming a huge ice cloud.

The ice cloud behavior was recorded by cameras and radar located in circling aircraft, on several islands in or near the Atlantic Missile Range, and at Cape Canaveral and Daytona Beach. The study was performed as part of the Office of Space Sciences' Project High Water. The first such study was made on *SA-2* when water was released at an altitude of 65 mi.

Weather shields, believed to be the cause of the *Centaur I* failure, were test-flown on an upper-stage



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# How you can avoid three costly mistakes in the selection of a scientific or engineering computer

And the one sure way
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Selecting a computer can be one of the most important decisions an executive can make. Almost any computer can reduce costs by solving problems, and saving time, but some are far more efficient than others.

This then should lead to a careful study of available computers. And the study must avoid becoming overconcerned with "nuts and bolts" and concentrate instead on overall suitability and purpose.

Basically, the decision has to depend on finding the computer that best serves your needs. The Recomp® line of solid-state scientific and engineering computers has been found ideal for many leading companies. Perhaps it could best meet your needs. The following common mistakes may offer some guidance in your choice.

**(1) "Get the cheapest computer"**

Just as there is no such thing as a cheap pair of shoes, there is no "cheap" computer. Scientific problem-solving computers sell from $40,000 and up. They lease from $1,000 and up a month. But, much more important than initial cost is how much a computer will save you over a period of time.

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casing of *SA-3*. A total of 11 pressure measurements were made to furnish information for *Centaur* design engineers.

The launch also permitted a test of the swing-arm umbilical connection with the upper portion of the first stage and verification of the umbilical tower design. *SA-3* was the first launch from Complex 34 since the umbilical mast was installed.

The umbilical was not used in connection with the launch, and it was disconnected at T−25 seconds. The umbilical connection used was in the pedestal, and contact was broken with motion of the booster.

• **Future changes** — A similar test flight is planned for next spring with *SA-4*. Principal change in the flight profile will occur when one of the eight engines is deliberately cut off while *Saturn* is airborne. *SA-4* also will have an external configuration closely simulating the *SA-5* vehicle, with the exception of the Block II stabilizing fins.

The *SA-5* flight, first of the Block II *C-1 Saturns*, will come in the fall of 1963 and another will be scheduled before the end of the year. The *SA-6* flight, first to use the ST-124 platform for guidance, will not be moved forward even though Pad B of Complex 37 will be ready next summer to accept the Block II vehicles and Complex 34 is rapidly being modified to perform a similar mission.

Von Braun said the *S-IV* stage, which will make its first "live" flight on *SA-5*, is to be given structural tests at Marshall in the next few months. These will include tests for vibration, bending and harmonics. The *S-IV* without engines was recently shipped from the Douglas plant to Huntsville.

He also said development of *Centaur* has no bearing on progress of the *S-IV*, which has made several full-duration tests at full thrust. He said the only thing *S-IV* and *Centaur* have in common is the liquid-hydrogen engine "and liquid-hydrogen technology is no longer a problem."

D. Brainerd Holmes, director of NASA's Office of Manned Space Flight, said complete success of the first eight *Saturn* flights might bring consideration of moving the manned *Apollo* flights forward, but he added such a mission is "unlikely before the 11th *Saturn*."

Portions of the engineering data acquired from 712 channels of telemetry will be used in design of the *C-1B Saturn*, which is due for its first test flight in 1965.

## Shots of the Week

The Army *Pershing* missile chalked up its 36th successful launch last week, but the Navy's advanced *Polaris A-3* missile failed for the fifth straight time.

The 150-mile *Pershing* fired Nov. 15 was a test of tactical procedures that will be used to fire the missile.

The launch utilized tactical procedures developed for helicopter type deployment of the missile.

In demonstrating the versatility of the *Pershing,* sections were pulled from shipping containers and mated using only standard Army tactical equipment. No gantry or service tower was used to prepare the missile for firing.

The Nov. 17 *Polaris* flight failed when the rocket's second stage veered off course and had to be destroyed. The destruct button was pushed 77 seconds after the missile was launched successfully and shortly after first stage separation.

The *A-3* will eventually have a range of 2900 miles, compared to 1375 miles or the *A-1* and 1725 for the *A-2*.

In another major launch, NASA's massive *Saturn C-1* booster made its third straight successful flight in three attempts (see story p. 12).

In other launches:

- The first joint U.S./Australian sounding rocket venture failed Nov. 15 when a malfunction in the launch vehicle occurred 38 seconds after launch at Wallops Island. A second launch will be attempted in December.

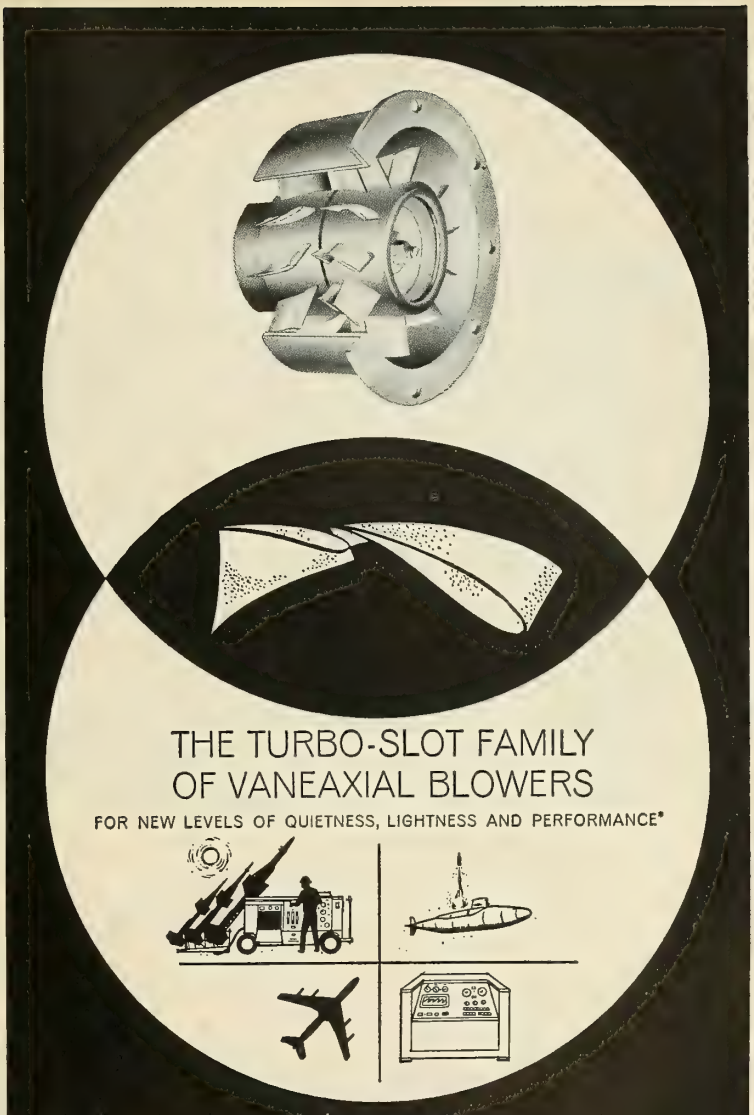
- The Air Force launched the 19th in its series of *"Firefly"* high-altitude probes. The 33-ft. *Aerobee 150* rocket made the successful launch from its test site at Eglin Air Force Base, Fla.

- The latest of 30 firings of Atlantic Research Corp. *Arcas* rockets in Antarctica was made successfully by the National Science Foundation. During the current series 60 of the rockets will be launched to 200,000 ft.

- *Minuteman* scored a success in a Nov. 19 launch from a silo at Cape Canaveral. The Air Force's "instant ICBM" went 3500 miles, dropping a dummy warhead into the South Atlantic some 30 minutes after launch. It was the first test for the 54-ft. Boeing missile since one went astray in a spectacular explosion Oct. 17 at the Cape.

## NASA Fills DOD-Liaison Post

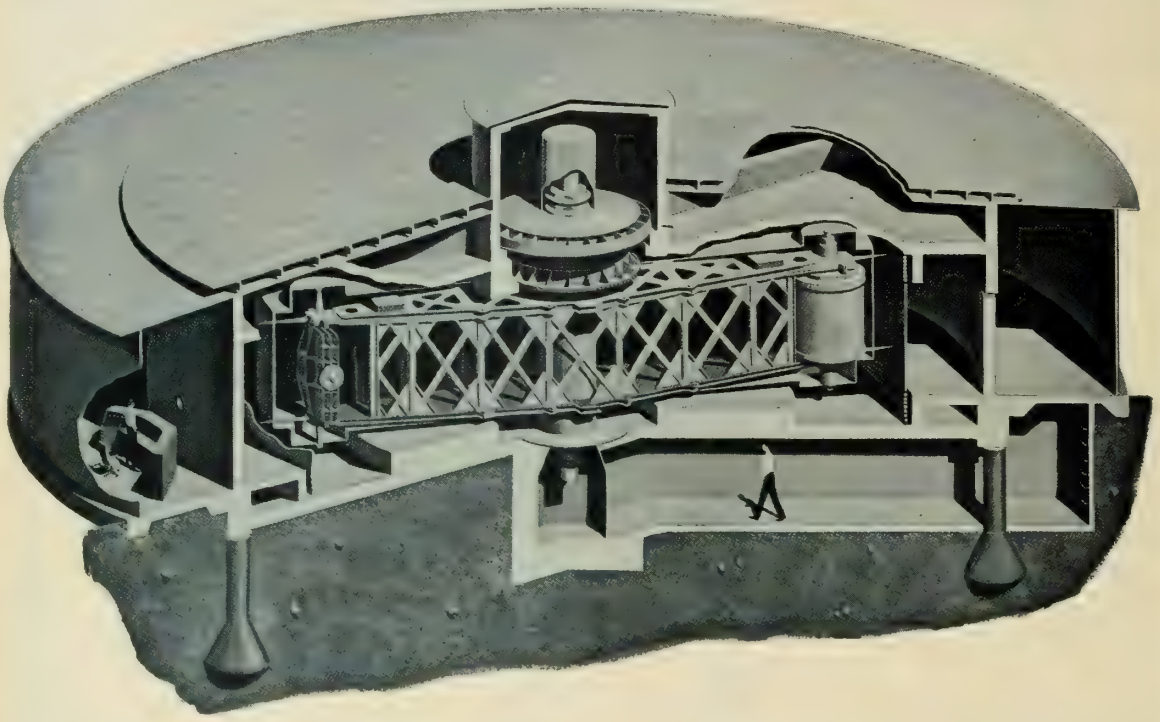
The space agency has set up a new office to improve NASA-DOD co-

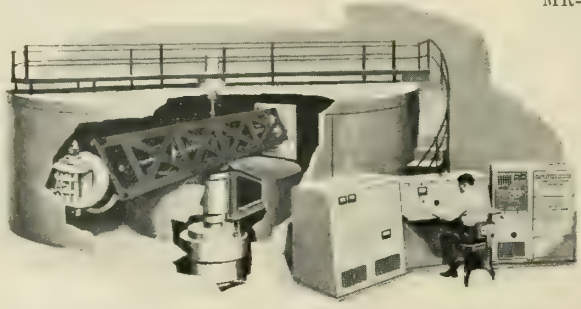
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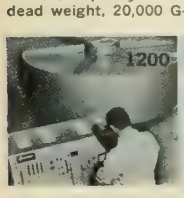
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operation in the space program.

Walter Fredrick Boone, a retired admiral, will head the new office as Deputy Associate Administrator for Defense Affairs.

Boone's primary job will be to coordinate the flow of technical and management information between the two agencies and to help achieve a better use of the resources of both agencies.

It was also announced that Dr. Robert C. Seamans, Jr., will replace Deputy Administrator Dr. Hugh L. Dryden on the Aeronautics and Astronautics Coordinating Board. Boone will serve as Seamans' alternate on the board.

## ARS Meeting Concludes

A spirited debate highlighted the final sessions of the ARS meeting in Los Angeles last week with Dr. Harold C. Urey of the University of California attacking the military role in space and Gen. Bernard A. Schriever, commander of the Air Force Systems Command, defending it.

The panel discussion also included Rep. George P. Miller (D-Calif.), chairman of the House Science and Astronautics Committee; Dr. William O. Baker, vice-president for research of the Bell Telephone Laboratories and Dr. H. Guyford Stever, MIT professor and chairman of the AF Scientific Advisory Board.

Urey declared that he would not "spend one effort of my little finger" for weapons in space. Conceding the usefulness of reconnaissance satellites, Urey said that he wished "the military would take care of its knitting and do it properly."

Finally, the famed scientist recalled former President Eisenhower's farewell remarks about the influence, sought or unsought, of the growing military-industrial complex.

In rebuttal, Gen. Schriever pointed out that the military must participate fully in space activity to maintain a force in being, particularly since adequate time for mobilization of resources is a thing of the past.

"You cannot put [the military] in a barn somewhere and then say, 'Now we need you, buddy—let's go up in space,' " he argued.

Congressman Miller took the position that the military could "pick up" what it needs from the civilian space effort.

"NASA buys its rockets to orbit its satellites from the Air Force, and the Air Force gets this [NASA] knowledge . . . so I don't see that




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we are neglecting the military," Miller said.

Pointing out that the military has developed many aircraft that have no civilian use, Schriever predicted that future military space systems will bear little resemblance to NASA deep-space exploration spacecraft. Present military space programs are getting enough support, he said, but noted that the five-year AF space program has not yet been evaluated by DOD.

"I don't know whether I'll be happy or unhappy in the future," he commented.

• Meanwhile, Secretary of the Air Force Eugene Zuckert and SSD's *Titan-III* Program Director, Col. Joseph S. Bleymaier, revealed that Dec. 1 is the "go-ahead" date for development of the standardized space booster.

Contracts are being signed with United Technology Corp., Martin Co. and Aerojet-General Corp. for the *Titan III* segmented solid booster motors, the liquid-fueled first, second and third stages of the core vehicles, the airframe, control module and systems integration, Zuckert revealed. All the contracts, he said, are cost-plus-incentive fee, and all subsequent contracts will be of the same type.

Col. Bleymaier outlined four technical challenges facing the AF-industry team, terming quality assurance "to a greater degree than heretofore demanded" as primary. This is most critical to the solid booster contractor, he said, since significant motor-to-motor deviations cannot be permitted.

With no method of in-flight thrust variation, the AF is asking guaranteed production and delivery of solid engines—in pairs, at least—with thrust variations no greater than one percent.

A second challenge is development of a malfunction-detection system and a consequent immediate and effective thrust termination in the solid boosters. Unlike the *Atlas-Mercury* system, Bleymaier said, the abort-sensing and implementation system in both the *X-20* and *Gemini* systems will depend on pilot judgment to a great extent.

Perfection of a multiple start-and-stop capability for the *Titan III* transtage propulsion is the third challenge, Bleymaier noted, while the specially designed integrated-launch-transfer facility for the *Titan III* will present the fourth development challenge.

Turning to the transtage of the *Titan III,* Bleymaier said that this would be a "switch engine" between the third stage of the core and the payload. It could place a payload into a parking orbit, and later, with a second firing, inject it into another orbit or trajectory.

After a transfer task, the transtage can remain connected to the payload, and with multiple re-start capability be used to maneuver payloads, add velocity increments, change velocity vector or provide retro-thrust—giving it a great potential for manned space missions. It will also be possible, he said, to launch a manned vehicle from Cape Canaveral into an orbit with an inclination of perhaps 50°, and then with the transtage re-orient the vehicle sufficiently to place it in polar orbit.

• Dr. Hugh L. Dryden, Deputy NASA Administrator, said three possibilities are being studied as follow-on programs to *Apollo:* further lunar exploration beyond early *Apollo* objectives, establishment of a large manned orbiting laboratory or manned missions to Mars and Venus. All three are currently under intensive study, Dryden said, and the final decision probably will not be made for about two years.

Admitting that he and many other space planners favor the orbiting laboratory, Dryden pointed out that "the main reason that this project was not selected over *Apollo* in the first place was that it was felt we had a better chance of matching or bettering Russia in a lunar race."

Although the orbiting lab could become available about the same time that *Apollo* is achieving its objective, money for the project cannot be made available in the next two years without exceeding budget schedules.

A determination of just when it should be introduced into the space program "must wait until after *Apollo* expenditures have peaked next year," Dryden said. Military consideration, he indicated, will enter into the decision.

## Army Cancels AN/USD-5

In a surprise move last week, the Army cancelled the high-speed, jet-powered *AN/USD-5* surveillance drone under development by the Fairchild Stratos Corp.

While the drone was technically feasible, the Army explained, it would cost too much for quantity procurement to provide an effective capability. Termination of the program is expected to save $30 million in development costs, the Army said.

The surveillance mission originally contemplated for the *AN/*

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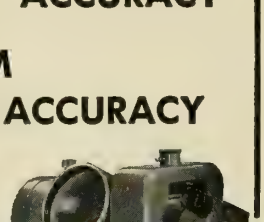


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*USD-5* will continue to be performed by the Mohawk aircraft and the *AN/USD-2* drone—the latter, a shorter range, lower-performance system developed by Aerojet-General Corp.

## Project Fire Work to GD

General Dynamics/Astronautics has announced it will do systems integration for NASA's Project Fire high-speed re-entry program under a contract GD has to supply *Atlas* launch vehicles for the program.

In Project Fire, two spacecraft will be launched separately late in 1963 from Cape Canaveral on ballistic trajectories some 5200 miles over the Atlantic Missile Range.

They will undergo accelerated re-entry into the Earth's atmosphere at more than 25,000 mph.

Re-entry velocity of 25,000 mph will duplicate conditions at which a spacecraft would return from the Moon without any means of retro-firing rockets. Data obtained during re-entry will be used to determine total heat transfer, hot-air radiance, materials response and radio black-out effect.

Each of the two systems to be launched will include, besides the *Atlas Series D* launch vehicle, a velocity package built by Chance Vought Corp. and a re-entry vehicle built by Republic Aviation Corp.

After the *Atlas* has achieved the desired trajectory, its retro-rockets will ignite and the remainder of the system will continue in free flight downrange. Before re-entry, an 180-rpm spin will be imparted to the velocity package/re-entry vehicle to give it added stability during rocket engine burn.

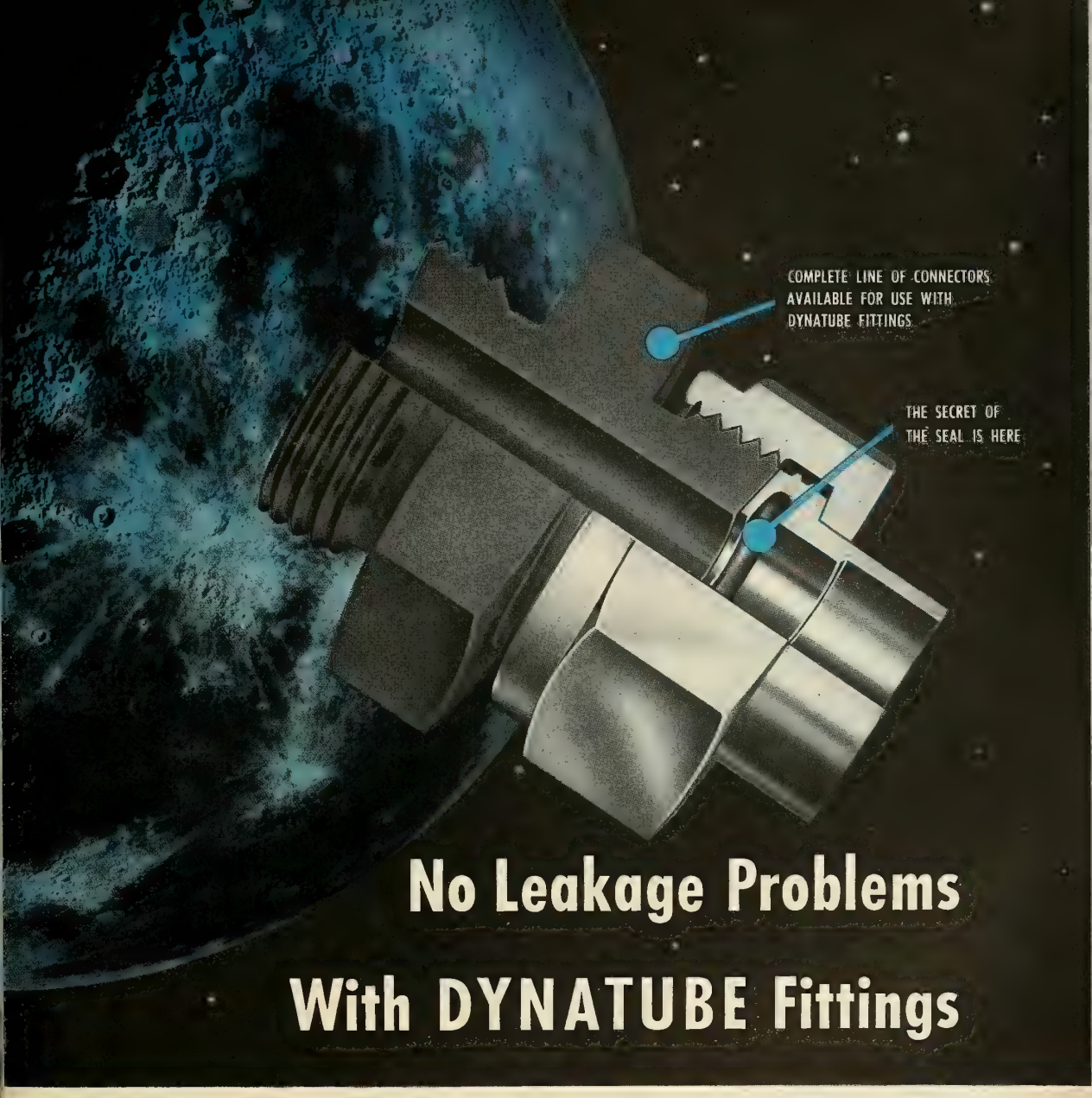
The guidance package will be separated and the velocity package will be ignited to drive the 250-lb. blunt shaped re-entry package down into the atmosphere at Moon-to-Earth velocity. The velocity package incorporates an Allegany Ballistic Laboratory *Antares II A* rocket. It is 11 ft. long and 30 in. in diameter.

When the velocity package burns out, the re-entry package will separate. During re-entry, data will be telemetered to ground stations of the Atlantic Missile Range on Ascension Island and ships in the broad ocean area. Recovery is not planned.

General Dynamics/Astronautics will monitor integration and operational activities of the other two companies on all systems and subsystems in Project Fire.

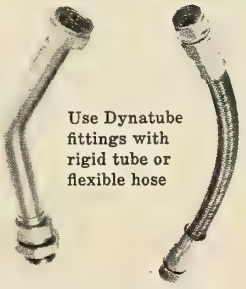
## Hughes Gets MMRBM Award

Hughes Aircraft Co. was selected last week by the Air Force as the integration, assembly and checkout




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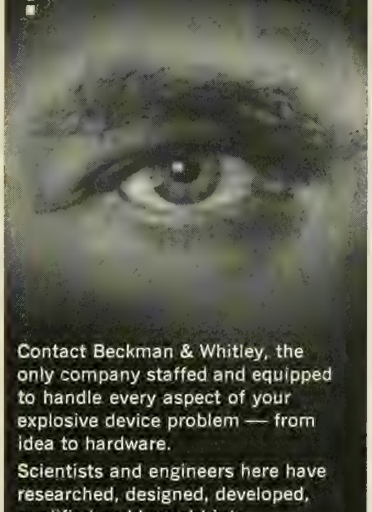
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contractor for the program-definition phase of the *Mobile Mid-Range Ballistic Missile (MMRBM)*.

The selection completed the contractor structure for the program-definition phase and left only one area still to be decided if the program is approved for development.

The command and control selection, with Hughes competing against Martin Co. in association with Sylvania Electronics, Inc., is being postponed because DOD feels that the complexity of the problem warrants more than one contractor during the feasibility study.

Program definition phase contractors are:

—Integration, assembly and checkout: Hughes.

—Re-entry system: Ford Aeronutronic in association with Fairchild-Stratos and Sperry Rand.

—Propulsion: Thiokol.

—Transporter-launcher: Goodyear Aircraft.

—Guidance and control: General Precision.

—Command and control: Hughes and Martin/Sylvania Electronics.

A decision to develop the *MMRBM* has not been made, DOD stressed, but will be contingent on the results of the program definition.

## British Contact Mars-1

Scientists at the British Jodrell Bank observatory established contact for the first time with the Soviet spacecraft *Mars-1* Nov. 16. Using their 250-ft. radio telescope, Jodrell scientists received signals from the space probe for about an hour. The vehicle was reported about three million miles from Earth.

Jodrell Bank had been asked by Soviet scientists to search for the vehicle and was furnished the necessary trajectory information.

## Soviets Boast SAM

Soviet rocketmen can shoot down airplanes flying higher than 20 km. (12.7 mi.) with an improved surface-to-air missile, artillery commander Col. Gen. Georgi Kariofilli said in a speech before Soviet Artillery Day.

He also asserted that the Soviet Union has developed a new ICBM which is "invincible to anti-rocket defense."




### *Model of Grumman Lunar Excursion Module*

*FIRST PHOTO RELEASED by NASA of its Lunar Excursion Module, which will land U.S. astronauts on the Moon by 1970. The module, to be built by Grumman Aircraft Engineering Corp., has five legs. The bottom section will be left behind when the top part leaves the lunar surface to rendezvous with the Command Module of the Apollo spacecraft, which remains in a lunar orbit while LEM performs its mission.*



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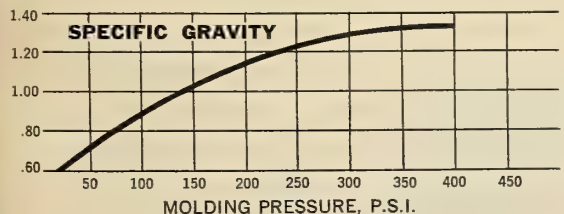
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Johns-Manville Thermomat, an asbestos-phenolic molding mat, creates components and parts that withstand tremendous heat and pressure. J-M Thermomat Style 383 was especially developed to provide exceptionally lightweight thermal shielding and the high strength-to-weight ratio so desirable for such low density molded material.

J-M Thermomat Style 383 is composed of an unbonded felt containing 100% ASTM grade AAAA long, randomly dispersed chrysotile asbestos fiber and lightweight fillers, saturated with a phenolic resin, conforming to military specification MIL-R-9299.

Flexible before curing, the partially dried felt is conformable and allows convenient one-man layups. Random fiber dispersion provides uniform, maximum reinforcement to the cured Thermomat. The unique characteristic of the felt allows easy working together of joints and permits free flow of the fiber during the molding operation. Even in intricate configurations, non-fillouts and resin-rich areas are reduced to a minimum. Thermomat's remarkable draping ability saves many man hours of layup time. Molded parts can be easily machined and finished into precision parts with close dimensional tolerances.




Thermomat 383, as delivered in felt form, is ideally applicable to layup and low-pressure vacuum bag molding. However, the versatility of the felt makes it readily adaptable to pressure laminating and match die molding when properly "B" staged.

Based on scientific laboratory tests, Thermomat 383 at 1/3rd the thickness and at 1/9th the weight of standard asbestos-phenolic molded parts has the same thermal shielding effect at 310°F mean temperature.

J-M Thermomat 383 is supplied in uncured felts 14" wide, approximately 12' long and ¼" thick. When stored at temperatures not exceeding 40°F it has a shelf life of at least six months.

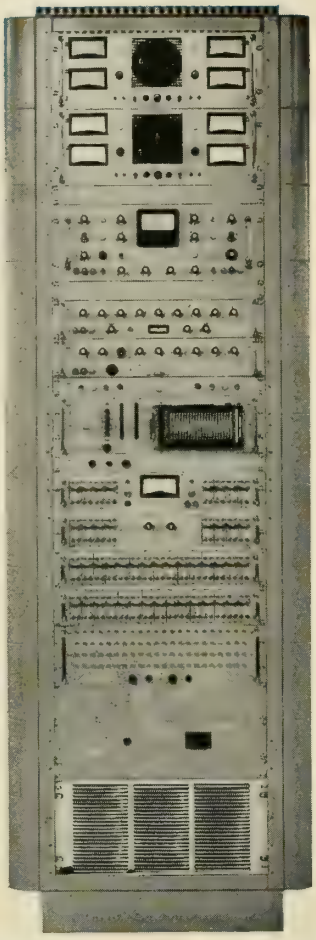
Thermomat is also available in other felt styles and in tape form with various properties. See your J-M Representative for further details, or write to Johns-Manville, Box 359, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE THERMOMAT

JOHNS-MANVILLE JM PRODUCTS

ARNOUX'S SERIES TDS 300 —

**PROVEN RELIABILITY IN TELEMETRY DECOMMUTATORS**



■ Arnoux's PAM, PDM, PAM/NRZ Series TDS 300 decommutator offers improved reliability, improved packaging design, and greater operating ease through less-critical adjustments. Arnoux decoms are widely used and known around the world. Arnoux's telemetry instrumentation and components are backed by an established, solid reputation of leadership in decommutation-equipment design and manufacture. ■ The TDS 300 features an input of from 0.5 to 60 v peak-to-peak . . . switch-selected, standard IRIG pulse rates; optional nonstandard PAM, PDM, PAM/NRZ pulse rates from 5 to 3600 pps . . . automatic compensation for commutation-rate change of up to 40 percent; manual compensation up to 80 percent . . . unaffected by SCO dc-level shift and discriminator-frequency zero shift without use of servo (within limits of discriminator pass band) . . . output-signal slope-off of 0.00005 percent/msec of frame (for 5 to 3600 pps) . . . accessory electronic gain and zero servo provides essentially drift-free operation. ■ Shown below: an Arnoux, completely-assembled, 17-rack, telemetry data-acquisition station at a major installation. Five TDS 300's are included, as well as receivers, discriminators, tape recorders, pen recorders, galvanometers, and test equipment.



ARNOUX

**ARNOUX CORPORATION**

(a subsidiary of The Electrada Corporation)

11244 Playa Street, Culver City, California

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## NASA Invites MSC Bids

NASA has invited 10 industrial firms to submit bids by Dec. 7 for a contract to build an integrated control center at the agency's Manned Spacecraft Center, Houston, and to integrate ground operational support systems to be used in *Apollo* and the rendezvous phases of *Gemini*.

Invited to bid were Bendix Radio, GE, Hughes Aircraft, IBM, ITT, Lockheed, Philco, RCA, Raytheon and STL. Potential subcontractors were urged by NASA to contact these firms, the controls systems procurement office at MSC, Houston, or the NASA headquarters office of industry systems for more details.

At a contract cost of about $80 million, Western Electric performed a similar task for NASA in the *Mercury* program. NASA officials expect this contract to be less costly, since in many cases modification of existing facilities would be the main requirements.

In another contracting area, NASA has called for proposals by Dec. 10 for a flight prototype of a system to measure carbon dioxide for possible use in manned spacecraft. The contract is being handled by the Houston center's general research procurement office. At the same time NASA said it would negotiate with General Electric Manufacturing Co. for development, fabrication and delivery of two prototype fuel cell principal oxygen measuring systems.

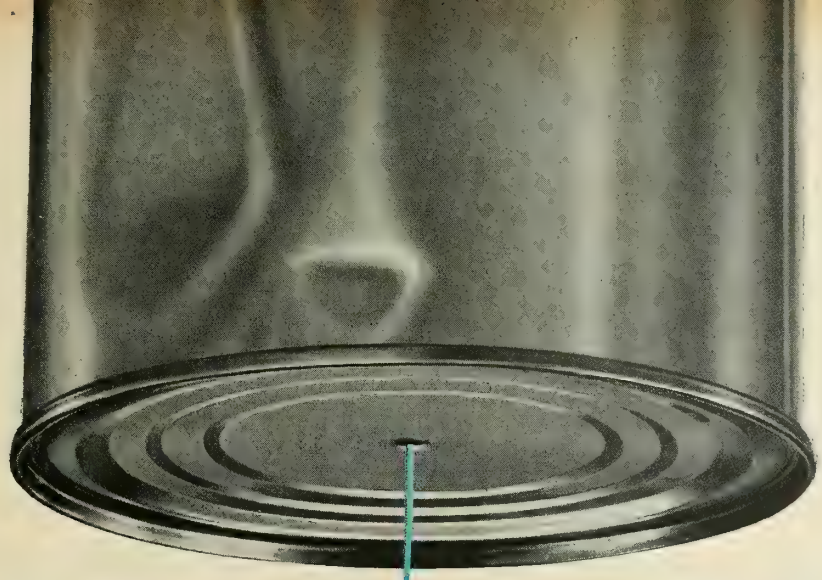
## Nimbus Testing Advances

The first *Nimbus* flight model may be ready by June, 1963, and launch is scheduled for the third quarter.

About 250 industry and NASA representatives inspecting GE test facilities at Valley Forge, Pa., were told last week that vibration tests on the spacecraft have been completed, and three-axis testing has begun.

The spacecraft is "flown" on an air bearing in the simulation chamber. All subsystems are now ready to go, and are being integrated for environmental testing.

Goddard Space Flight Center is systems contractor for the meteorological satellite, and General Electric is subsystems integrator and stabilization and control contractor. NASA's chief of Aeronomy and Meteorology, W. C. Stroud, chaired the two-day session.

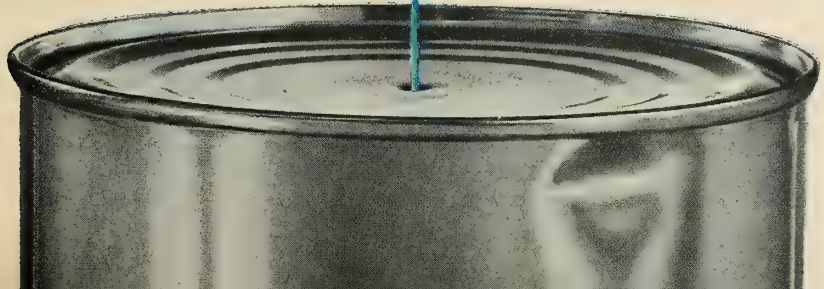


# Need a replacement for obsolescent communications?

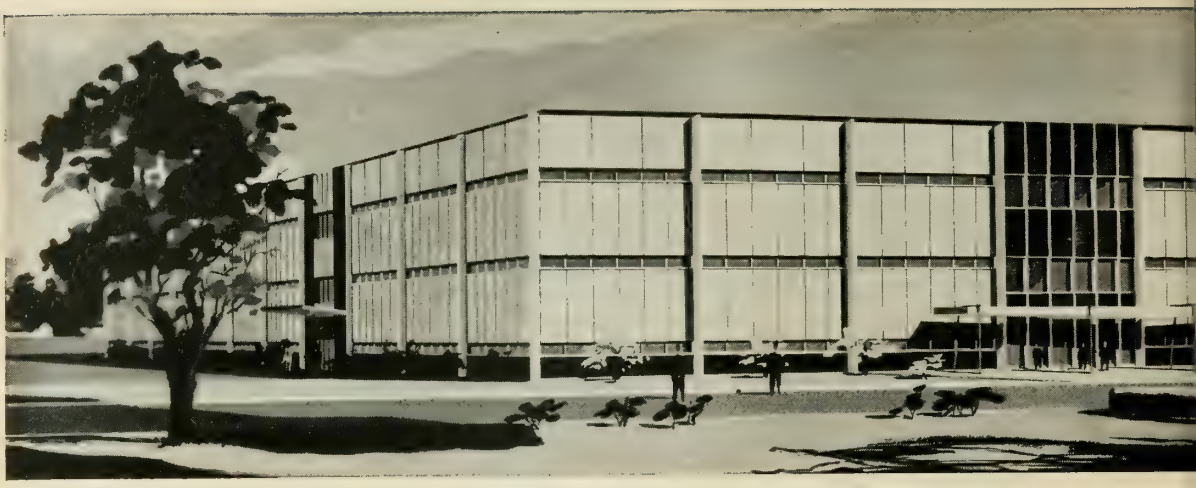
From tin cans to laser systems, the path of communications has transcended language, wars and centuries. On the ground, at sea, in the air . . . and now in space . . . the system of today has always become the tin can of tomorrow. ☐ For more than a decade, research and development by Electronic Communications, Inc., has helped set the pace in advanced and reliable communication. Among ECI's significant achievements are – the first UHF airborne multiplex system, the first self-focusing multiple-element antenna array, the first airborne 50-watt UHF command set, the first demonstration of unequal array spacing techniques, the first airborne 1-kilowatt servo-tuned UHF transmitter and the first development of a one-millimeter superheterodyne radiometer. ☐ If your communications system is losing the battle of time, take advantage of ECI research and development . . . it may dramatically improve your present methods. To find out what's new in communications . . .

**.....Ask**

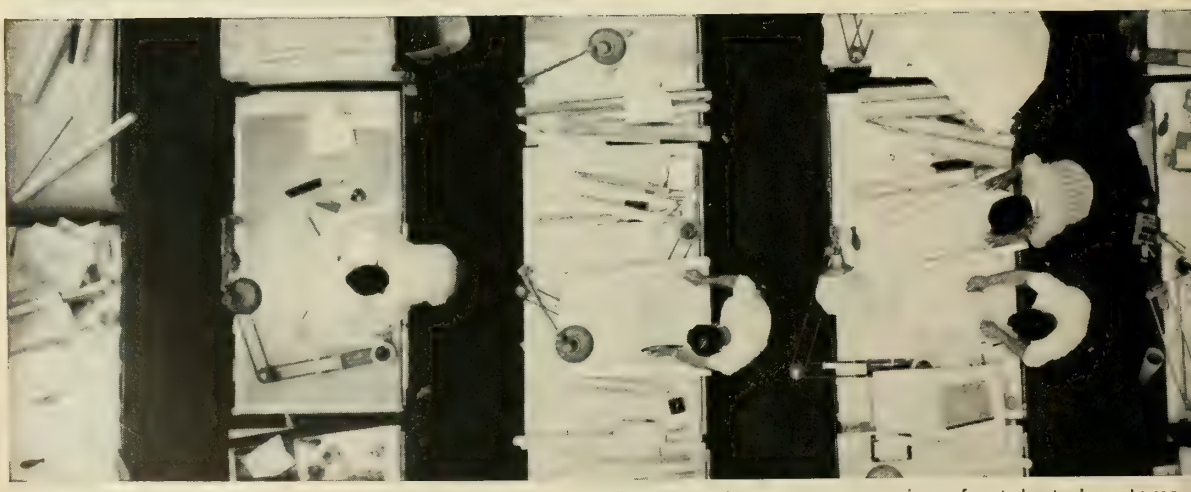
**ELECTRONIC COMMUNICATIONS, INC.**
**St. Petersburg, Florida**



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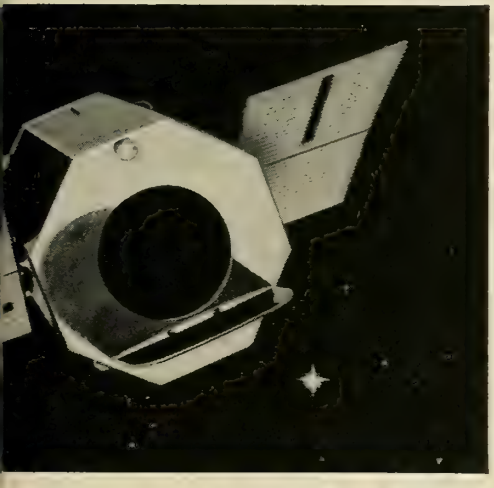


Grumman has unique openings for talented systems-oriented engineers and scientists to supplement and enhance our provocative space programs. See our ad, page 198.



# FACILITIES

Latest step in Grumman's long-range aerospace programming is construction of a new $5 million Space Engineering Center, shown here in an architect's drawing. Along with the recently completed Electronics Systems Center and in-progress Research Center, this new complex of aerospace facilities will give Grumman the physical capabilities and resources to undertake major space system assignments.



# EXPERIENCE

In the early 1950's, Grumman instituted a comprehensive, long-range program of space studies. Significant areas were hypersonics, reentry, capsule retrieval, orbital transfer and lunar vehicles. Major accomplishment to date is acquisition of the OAO (Orbiting Astronomical Observatory) contract and the Echo II canister assembly. More recent study contracts include the performance study for Lunar Logistics Systems and a new contract study in Lunar Astrodynamics. Against the background of 33 years' experience in solving the man-machine equation in aircraft and weapons systems, Grumman now offers a fully integrated space capability.



**AND ESPECIALLY**

# PEOPLE

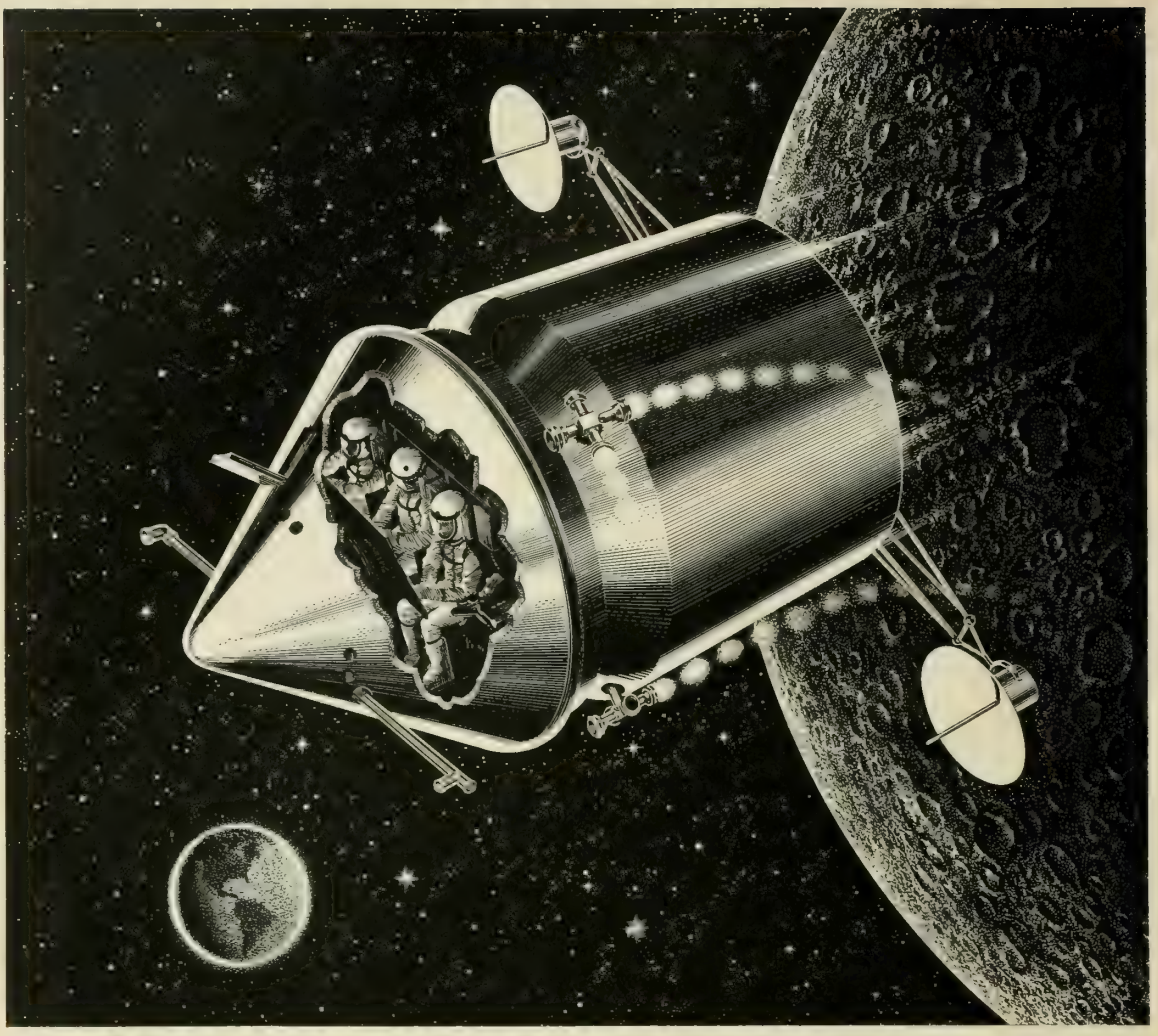
Grumman's most valuable asset is people: scientists, engineers, technicians and craftsmen. This work force provides an unbroken network of interlacing aerospace experience and skills. Over all is a management team with the uncommon knack of fitting man and machine together . . . of correlating large-scale programs simultaneously . . . of ensuring "total company" effort . . . of transforming advanced ideas into reality. The Grumman work force is by far the most stable in the industry.

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## Reaction control engines for Project Apollo

Marquardt is currently engaged in the development and fabrication of the reaction control rocket engines for the service module of the Project Apollo Spacecraft—The National Aeronautics and Space Administration's initial manned expedition to the moon. The Marquardt engines in the service module are part of the flight and stabilization control system, providing attitude control and stabilization enroute to the moon and back, and during lunar and earth orbit.

Marquardt has successfully designed and built advanced control systems for aerospace vehicles for nearly two decades. Absolute reliability and precise accuracy are necessary for satellite rendezvous, station keeping, orbit control, landing and lift-off from distant planets. Reaction control systems by The Marquardt Corporation are relied on to do these vital jobs.

*Engineers and scientists interested in joining Marquardt on Apollo and other significant aerospace projects are invited to direct résumés to Professional Personnel at the address below.*

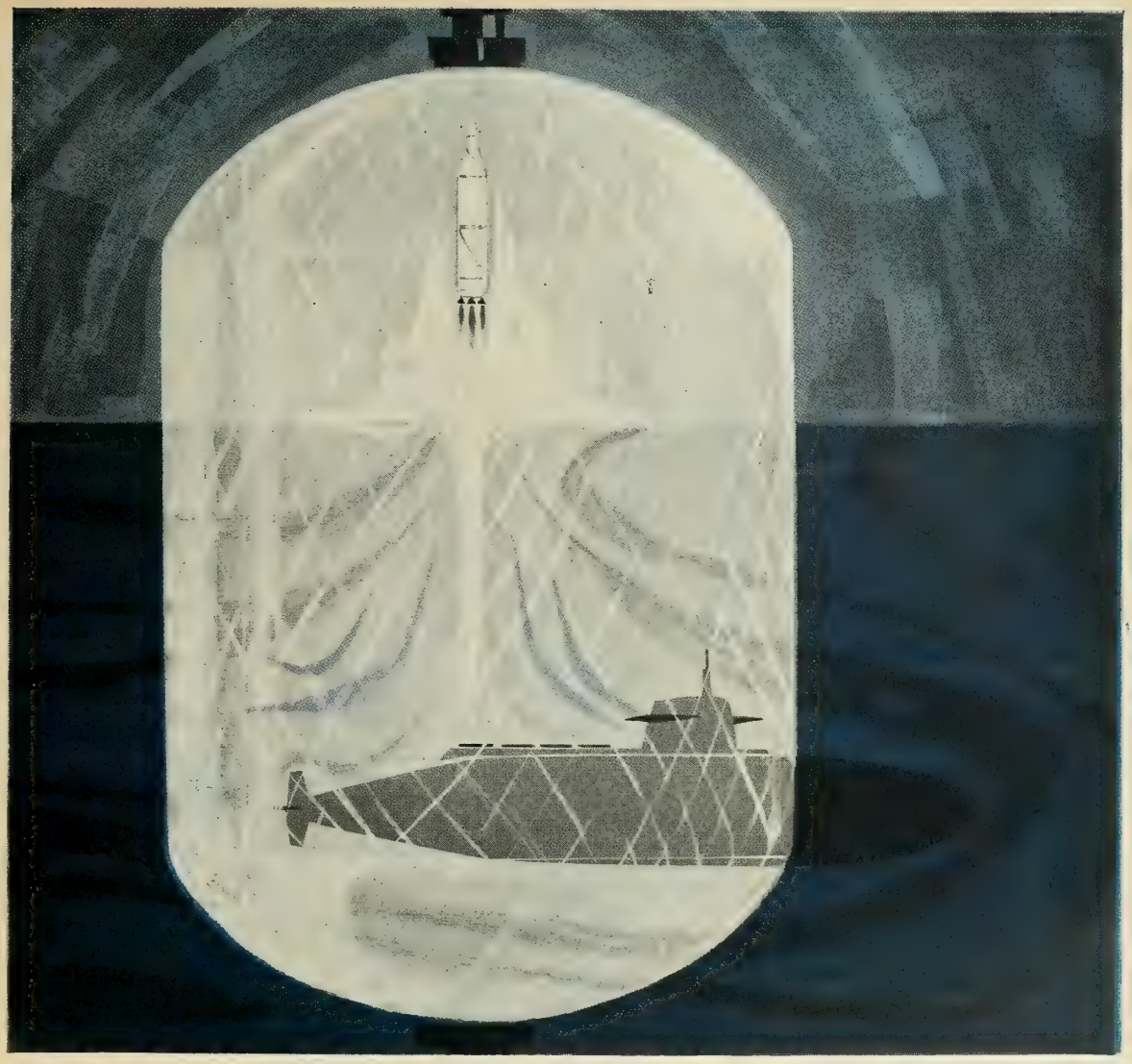
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# Polaris Range is Increased Through the Use of Filament Wound Motor Cases

The Defense Products Division, Brunswick Corporation, was selected by The United States Navy as a participant in the design and fabrication of prototype second stage Polaris A-3 rocket motor cases. Brunswick's design and fabrication know-how from previous programs was an important factor in being selected to produce this advanced high strength–low weight motor case.

Experience obtained from various rocket motor case programs, including the Polaris, has resulted in an unexcelled capability for motor case design and fabrication. Brunswick offers a wide range of materials experience including the latest high strength reinforcements and resin systems.

From the fabrication of the insulator to the hydrotest of the completed motor case, Brunswick can supply complete "in house" capability. Original design concepts supported by computer analysis insure optimum motor case design for maximum strength/weight ratio. Semi-automatic fabrication equipment and mechanically controlled resin content result in a uniform reliable product.

Let Brunswick scientists and engineers analyze your requirements. Brunswick's demonstrated capabilities in filament winding assure the successful completion of each customer's contract.

*Interested engineers will find it rewarding to discuss career futures with Brunswick, an equal opportunity employer. Write or call Brunswick Corporation, Defense Products Division, 1700 Messler Street, Muskegon, Michigan.*

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# MERCURY JOURNAL



NASA's First Administrator T. Keith Glennan, and Pres. J. S. McDonnell Disclose Mercury Configuration 12 January 1959

**29 July 1958** . . . . . President Eisenhower signed bill creating the National Aeronautics & Space Administration (NASA).



McDonnell Project Engineers Establish Production Plans



Astronauts Visit McDonnell 12 May 1959



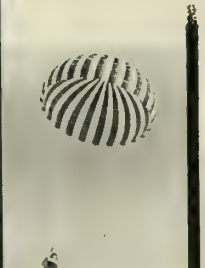
Big Joe R & D Capsule 9 September 1959



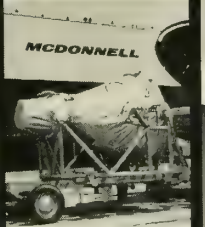
Little Joe Tests 1959-61



Hypervelocity Impulse Tunnel Tests



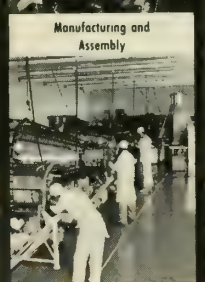
Paradrop Tests



#1 Spacecraft Delivery 2 April 1960



Manufacturing and Assembly



Final Manufacturing and Testing in White Room



McDonnell Engineers Perform on Site Checkout

**1 October 1958** . . . . NASA began official operation.

**21 October 1958** . . . NASA announced a competition for a manned spacecraft, to be launched by an Atlas, placed in orbit around the earth and returned safely. A McDonnell study team, which had been working on manned orbital spacecraft for 11 months under company research budget, was assigned to prepare the proposal.

**12 January 1959** . . . NASA announced selection of McDonnell to build Mercury Spacecraft.

**13 February 1959** . . . Contract was signed with McDonnell for the design and construction of 12 manned orbital Mercury spacecraft. As the program expanded, subsequent orders were received for eight additional spacecraft, two procedural trainers, an environmental trainer, seven check-out trailers and much of the prelaunch operation at Cape Canaveral, including the mating of the spacecraft to the launch vehicle, check-out and countdown.

**9 April 1959** . . . . . NASA announced names of the seven Mercury Astronauts.

**9 September 1959** . . NASA-produced "Big Joe" R & D spacecraft launched to test basic Mercury design concept. Spacecraft survived high heat and airload and was recovered.



Abort Rocket Test 9 May 1960



First Mercury-Redstone Flight 21 November 1960



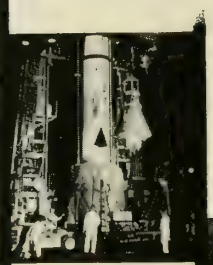
Ham—the Astro-Chimp



Procedures Practice in Simulator



Launch—Checkout Trailer



Freedom 7 Spacecraft Hoisted Aboard Redstone



A-OK for Astronaut Shepard 5 May 1961



Launch Preparation for Astronaut Grissom

**4 October 1959** . . . . Little Joe I fire at NASA's Wallops Station, Va. checked matching of launch vehicl and NASA-produced spacecraft. Th Little Joe test series enabled earl evaluation to the spacecraft in th high aerodynamic pressures en countered at low altitudes.

**4 November 1959** . . . Little Joe 2 fire from Wallops. Evaluated low-altitud abort conditions.

**4 December 1959** . . . Little Joe 3 fire at Wallops Station to check hig altitude performance of the escap system under high airloads. Rhesu monkey "Sam" used in successfu flight.

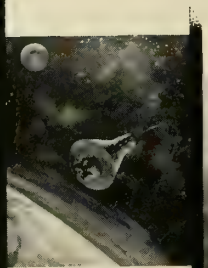
**21 January 1960** . . . Little Joe 4 fire at Wallops to evaluate escape syster under high airloads. "Miss Sam" another Rhesus monkey, served a test subject.

**25 January 1960** . . . Less than a yea after signing of contract, McDonne delivered first production spacecra (#4).

**2 April 1960** . . . . . First instru mented spacecraft (#1), with escap tower, delivered to NASA b McDonnell.

**9 May 1960** . . . . . Spacecraft # fired in an off-the-pad abort escap rocket test.

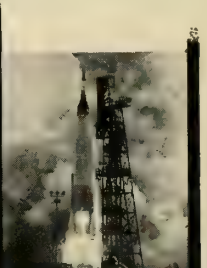
**29 July 1960** . . . . . Mercury-Atla 1. The first Atlas-launched flight wa aimed at qualifying the productio spacecraft under maximum airload and afterbody heating rate durin re-entry conditions. Spacecraft (# carried no escape system or test sub ject. Test objectives were not achieve due to launch system malfunctio



Mercury Orbits with "Mechanical Man" 13 September 1961



Friendship 7 and John Glenn



Liftoff for Astronaut Carpenter 24 May 1962



They Safely Return



*Days of achievement follow months and years of creative engineering and planning.*

**November 1960 . . .** Little Joe 5 fired om Wallops to check production pacecraft (#3) in an abort simulating ie most severe Little Joe launch ehicle airload. Premature spacecraft paration signals resulted in early ring of the escape tower and loss of st objectives.

**1 November 1960 . .** Mercury-Red-one 1 was the first scheduled un-anned Redstone-launched flight. remature engine cutoff at launch rminated the test. The emergency cape system was jettisoned. Space-aft (#2) was not damaged and test as rescheduled.

**9 December 1960 . .** Mercury-Red-one 1A was a repeat of November tempt. Successful flight reached a eak altitude of 135 statute miles and overed a horizontal distance of 236 atute miles. Spacecraft (#2) was covered.

**1 January 1961 . . .** "Ham", the 37-ound Astro-Chimp, was rocketed to space history aboard Mercury-edstone 2. "Ham" and spacecraft 5) were recovered after reaching an titude of 155 miles and landing 20 miles downrange. Flight demon-rated ability of primate to react ormally in prolonged weightless ght. "Ham" was recovered safe and ell.

**31 February 1961 . . .** Mercury-Atlas reached an altitude of 108 miles id speed of 13,000 mph. Flight ecked maximum heating during orst possible re-entry conditions. pacecraft (#6) was recovered 1,425 iles downrange.

**21 March 1961 . . . . .** Little Joe 5A at allops Station repeated Little Joe 5 st. Spacecraft (#14) was recovered t all test objectives were not met d shot was rescheduled.

**25 April 1961 . . . . . .** Mercury-Atlas 3 was an attempt to orbit spacecraft (#8) with a "mechanical man" aboard. Forty seconds after launching, the launch vehicle was destroyed by radio command. Spacecraft escape system functioned perfectly and spacecraft was recovered for reuse.

**28 April 1961 . . . . . .** Little Joe 5B completed the spacecraft escape system flight qualification tests. Spacecraft (#14) was reconditioned by McDonnell after previous flight and reused in this successful maximum dynamic pressure escape test.

**5 May 1961 . . . . . .** Astronaut Alan B. Shepard, Jr. rode Mercury-Redstone 3 into history with his ballistic flight seen by the world. The flight reached a peak altitude of 116 statute miles and was recovered 302 miles downrange. Spacecraft (#7) is now on public display in the Smithsonian Institute.

**21 July 1961 . . . . . .** Mercury-Redstone 4 was a successful downrange flight by Astronaut Virgil I. "Gus" Grissom. This was the first flight with the large window, greatly improving astronaut observation capability. Premature loss of the escape hatch caused spacecraft (#11) to take on water and sink despite determined helicopter recovery efforts. Astronaut Grissom was recovered from the water by helicopter.

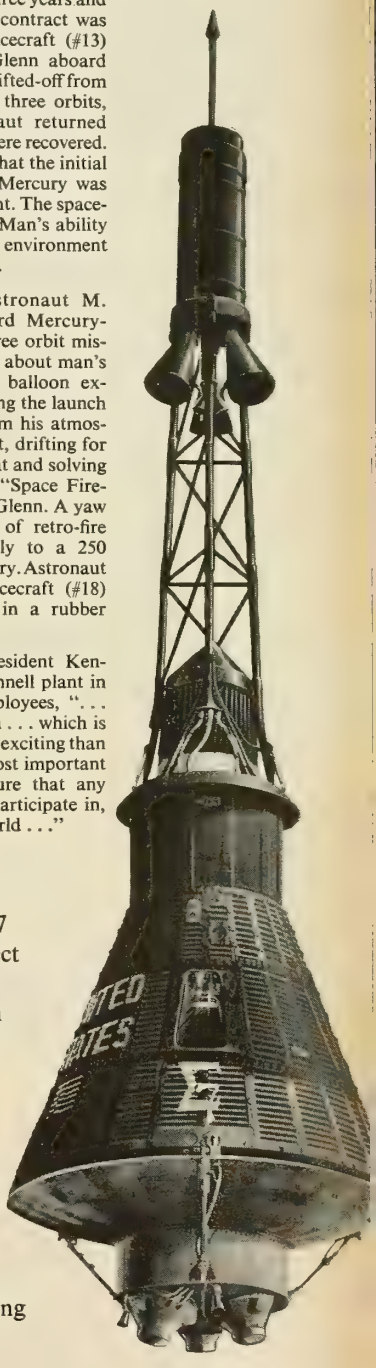
**13 September 1961 . .** Mercury-Atlas 4 placed the McDonnell Mercury Spacecraft in orbit for the first time. The spacecraft (#8) carried a McDonnell-developed "mechanical man" designed to use oxygen and add moisture to the cabin at the same rate as a man. The spacecraft was recovered after one orbit 160 miles east of Bermuda.

**29 November 1961 . .** Space-Chimp "Enos" twice orbited the earth in Mercury-Atlas 5. Spacecraft (#9) was recovered about 260 miles south of Bermuda.

**20 February 1962 . . .** Three years and 39 days after Mercury contract was awarded, Mercury Spacecraft (#13) and Astronaut John Glenn aboard an Atlas launch vehicle lifted-off from Cape Canaveral. After three orbits, spacecraft and astronaut returned safely to the earth and were recovered. It is significant to note that the initial assignment of Project Mercury was completed with this flight. The spacecraft had been proven. Man's ability to adapt to the space environment had been demonstrated.

**24 May 1962 . . . . . .** Astronaut M. Scott Carpenter aboard Mercury-Atlas 7 completed a three orbit mission, adding knowledge about man's visual perception with balloon experiments, photographing the launch vehicle and the sun from his atmosphere-free vantage point, drifting for long periods in free flight and solving the phenomena of the "Space Fireflies" first observed by Glenn. A yaw condition at the time of retro-fire contributed substantially to a 250 mile overshoot on re-entry. Astronaut Carpenter left the spacecraft (#18) and awaited recovery in a rubber raft alongside.

**12 September 1962 . .** President Kennedy visited the McDonnell plant in St. Louis and told employees, ". . . I can imagine no action . . . which is more essential and more exciting than to be involved in the most important and significant adventure that any man has been able to participate in, in the history of the world . . ."



**3 October 1962 . . .** Astronaut Walter M. Schirra, Jr., in his Sigma 7 Mercury Spacecraft (#16), completed a near-perfect six-orbit flight by landing on target in the Pacific Ocean off Midway Island. Much of the mission was accomplished in drifting flight by the United States' fifth man to go into space. The mission contributed additional knowledge about spacecraft control, space vision, and man's ability to work effectively in a prolonged weightless condition. The successful performance of Astronaut Schirra and Sigma 7 prepared the way for the planned one-day Mercury flight, and later 2-man McDonnell Gemini Spacecraft rendezvous flights. The flight was part of continuing U. S. space exploration programs.



Astronaut Schirra

FIRST FREE MAN IN SPACE

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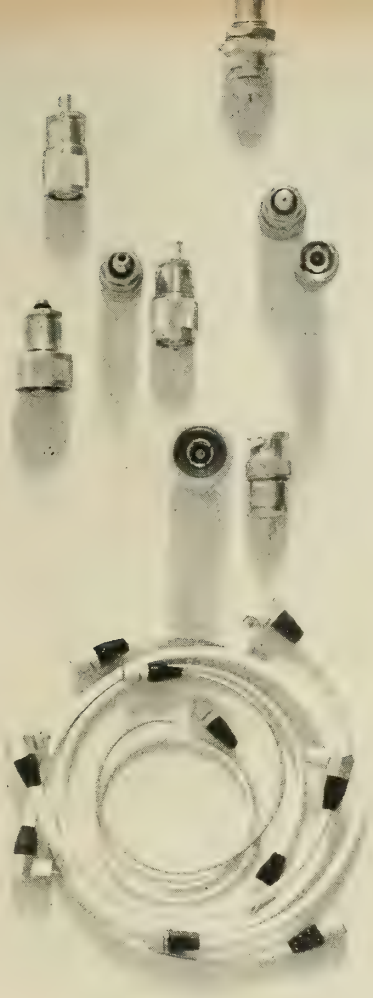
CLEVITE CORPORATION

MECHANICAL RESEARCH DIVISION

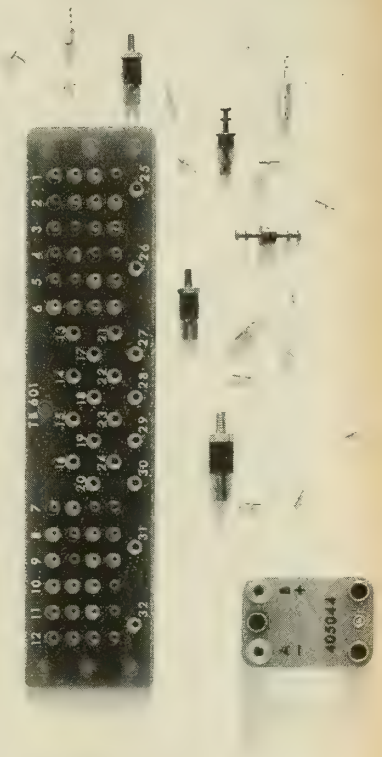
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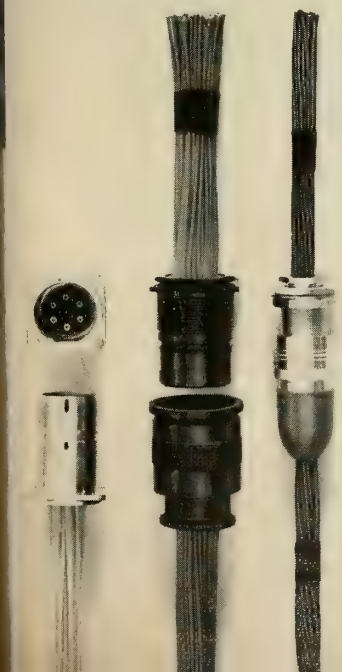


Contacts, connectors, cable, Lerco electronic hardware, complete harnesses and assemblies, hermetic sealing—Microdot supplies them all: miniaturized, in depth, mostly off the shelf. Because Microdot is very big on "little." Like:

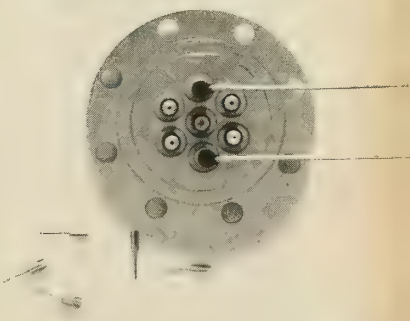
MICROMINIATURE MULTI-PIN CONNECTORS by Microdot are only ¼ the size of current "miniatures" and yours in 3 shell sizes—for up to 61 power or 19 coax contacts in a 1¼" shell. Parts are interchangeable; inserts available in a variety of straight power, straight coaxial and combination power/coax contacts. Hermaphroditic contact arrangements can be set up with power contacts that interchange without changing inserts. Order completely custom-assembled with Microdot cable or off-the-shelf in unassembled kit form. Check Bulletin MP-0.

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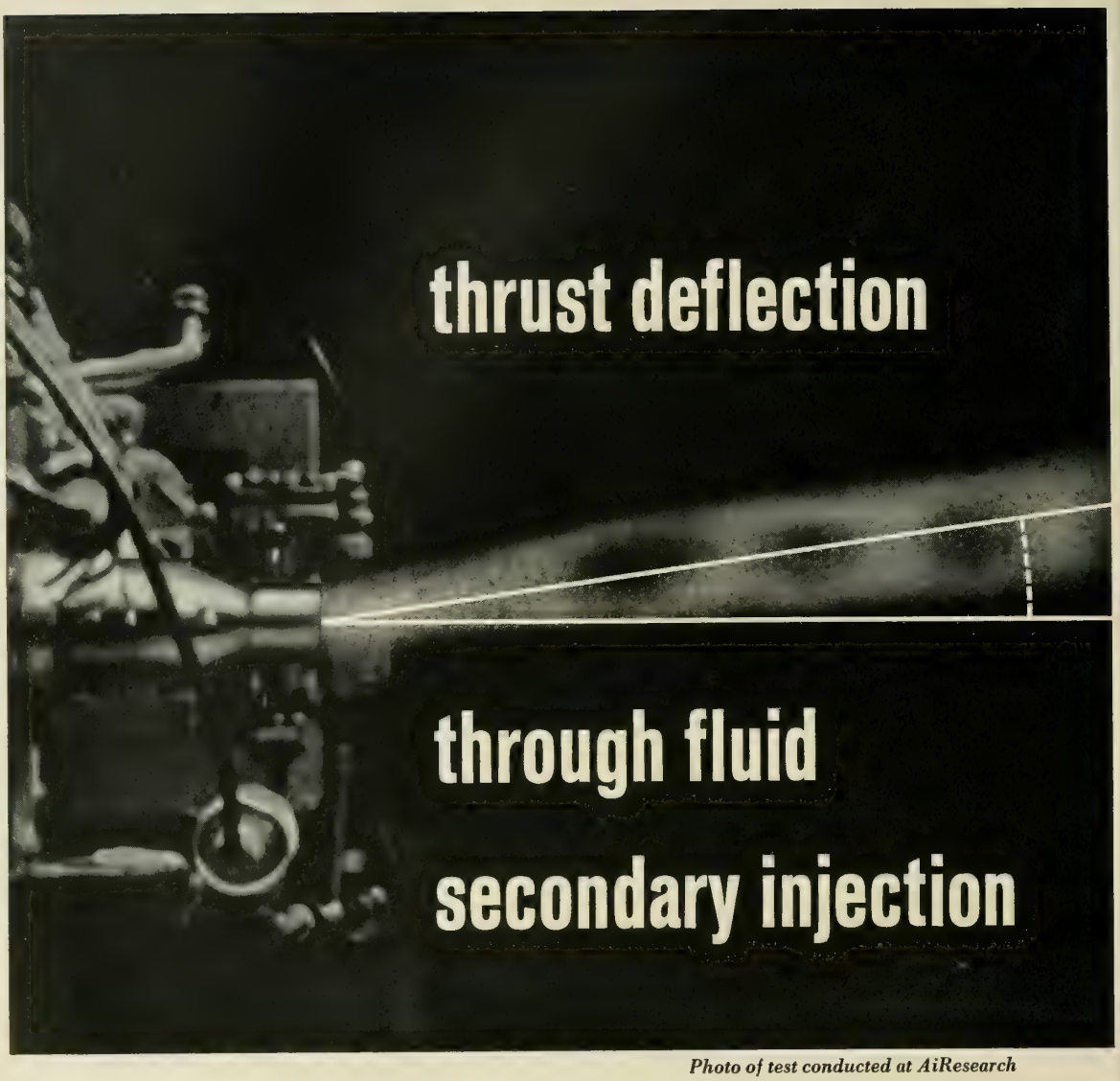



*Photo of test conducted at AiResearch*

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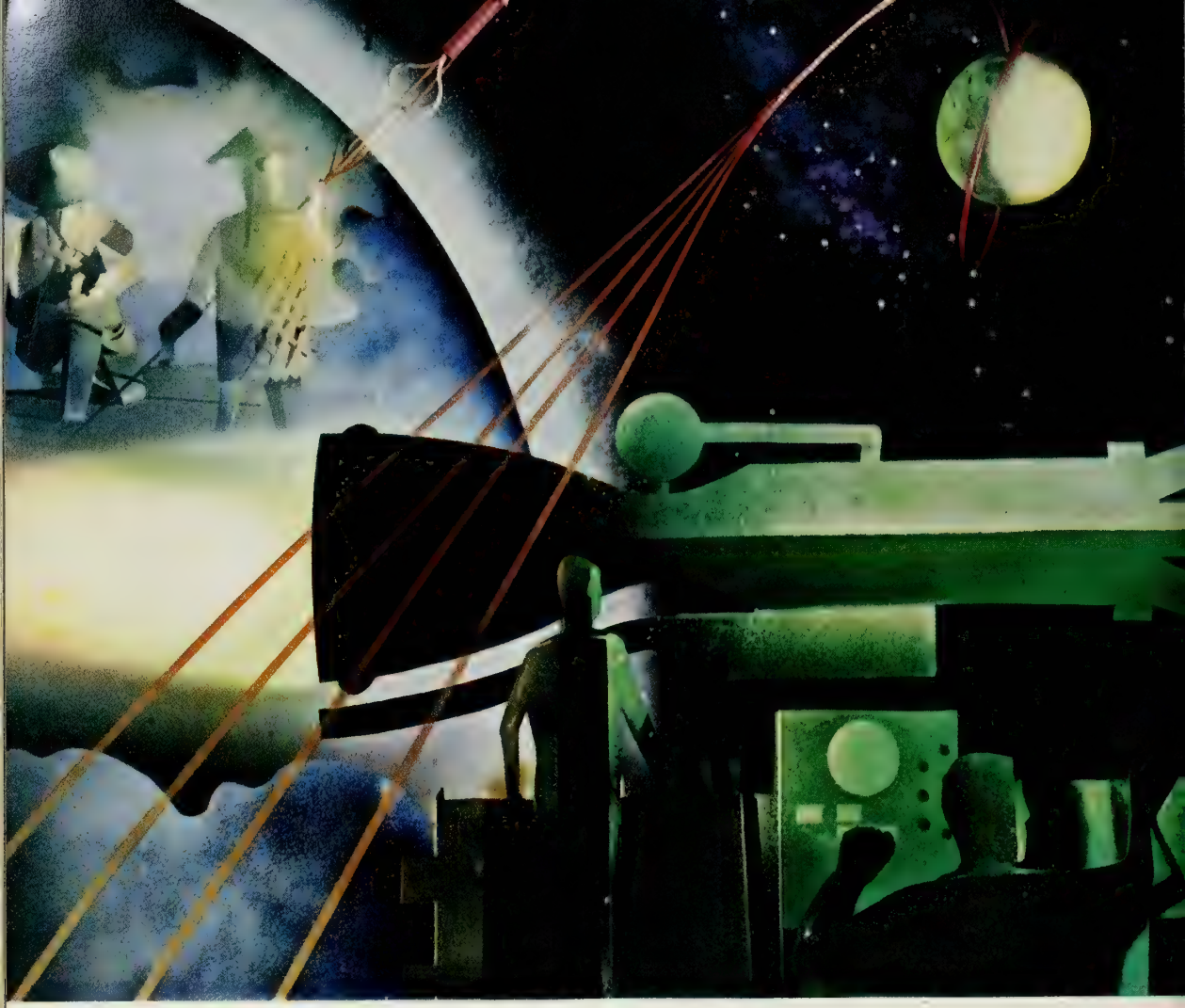
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• *History of rocketry from 13th Century China to the present symbolized*

## ROCKETRY... FROM KAI-FUNG-FU TO THE MOON

From the first-known use of rockets in the defense of Kai-fung-fu in 13th century China, rocketry has experienced anything but a continuous advance. For many hundreds of years these early fire arrows knew little improvement or new missions. Gradually they were given minor applications as signaling devices, incendiary weapons and lifeline launchers. Suddenly, in the last three decades, rocketry has made its breakthrough as a spectacular source of power.

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# DRIVE FOR THE MOON GAINS MOMENTUM




*NASA'S $50-BILLION undertaking to put men on the Moon and begin exploitation of space within this decade has made impressive progress in the past year. Funding to support the massive national effort, set at $3.7 billion in Fiscal Year 1963, will escalate to at least $5.5 billion—half again as much —in Fiscal Year 1964.* MISSILES AND ROCKETS' *Second Annual NASA Issue surveys the space agency effort by programs—what is to be accomplished in the relatively near future and what may be achieved by 1970. On the following pages, we examine overall budget plans and how NASA will procure what it needs from industry. Next are articles covering the programs involved in manned cislunar and lunar exploration, followed by reports on advanced manned and unmanned projects, launch vehicles, propulsion development, and the myriad satellite programs. A separate story deals with the huge construction program necessitated by the space effort. A final section contains up-to-date organizational charts of NASA's centers and a run-down of their functions and responsibilities in the U.S. space endeavor.*



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If you're starting from scratch with a new radar system . . . and want to save time and money . . . a good place to head is Goodyear Aircraft Corporation (GAC).

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Example: We make BMEWS antennas weighing 365,000 pounds with 84-foot-diameter dishes, 3-foot Luneberg lenses weighing 20 pounds—and virtually every type of structure in between for major systems like Nike-Zeus, Syncom, Tradex and Typhon.

We've also built and erected radomes for BMEWS, Nike-Zeus and other systems.

If you need help with a radar system . . . or any part of it . . . GAC can provide it. And we can also help you with advanced systems and technology—aerospace support equipment—electronic subsystems—lightweight structures—or missile requirements. Write Goodyear Aircraft Corporation, Dept. 14PV Akron 15, Ohio, or Litchfield Park, Arizona.

◀ Containing 50,000,000 cubic feet of space without a supporting column, this 18-story-high GAC airdock is big enough to house complete BMEWS antennas.

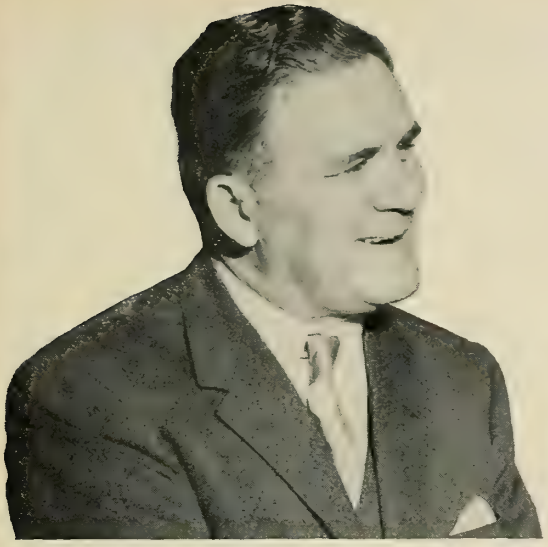
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*NASA Administrator Webb*

# Administrator's Watchword: Vigor with Prudence

A YEAR AGO, in an introduction to the first annual NASA issue of MISSILES AND ROCKETS, I said that by making prompt decisions we had "been able to get moving at high speed toward the accomplishment of our national goals in space."

During the intervening year we have continued to maintain a fast-paced national civilian space program, making significant advances in space exploration, and laying firm foundations for still further advances during the years ahead.

We have established, at Cape Canaveral, Houston, New Orleans, and in Mississippi, the massive ground installations which advanced manned space flight require. Further, we have placed under contract every major segment of the *Apollo* program.

In our space program we are building the foundations, the power, the capability to go forward to meet any national requirement in space which our processes of decision bring forth and ratify.

No one could participate in the management of our program, and the decisions which are required to carry it out, without a keen awareness that there are those who believe that the nation should proceed at an even faster pace, that every resource available through science, technology and industrial capacity should be utilized to the limit. As the aerospace industry develops new capability in advanced fields and phases out its work on manned aircraft, some suggest that the space program should be expanded to utilize these resources.

Although the *Advanced Saturn* will orbit a payload roughly equal to 85 capsules like that of John Glenn, some express the conviction that an even larger booster, the giant *Nova,* should be put under contract at this time.

Most scientists and experts on space believe this large booster will ultimately be required for the time period following our lunar exploration. However, several questions are involved in determining when to undertake it. To begin now would add, in the years immediately ahead, large financial requirements. Further, since the *Nova* is not required for our initial lunar explorations, delay gives us the opportunity to consider more thoroughly precisely how big it should be to meet future requirements.

In addition, we need to know more about how rapidly nuclear power can be developed for rocket propulsion, and whether solid fuels may be developed at so rapid a rate as to offer advantages over liquid fuels for the first stage of such a booster.

The present program, even without *Nova,* is designed to achieve the pre-eminence we need in all phases of space science, space flight, space exploration, and space utilization. It is expensive. Those of us charged with its management are devoting every capacity and every skill we have toward pushing it as a driving, vigorous effort, but conducted in a prudent and efficient manner.

Except in wartime, no national scientific and technological effort has had such a rapid buildup as the space program over the past five years. The end of the buildup is not in sight, but the rate is slowing down and is keyed to the policy I have stated—that this is a fast paced, driving, prudently managed and efficiently conducted program, but it is not a crash program.

Our program is proceeding on a realistic schedule, but it is constantly undergoing vigorous re-examination to determine how to use the resources provided to achieve pre-eminence in space at the earliest feasible date. There has been internal rearrangement but no slip in our lunar target dates. But despite the rapid buildup of our funds, our technological progress and the need for additional scientific data to support further advances has been even greater. Hard decisions must be made each day to allocate funds most effectively.

I BELIEVE we have, in NASA, the technical and financial management to make these choices and to achieve the results for which this program was established. Barring some unforseen opportunity, or new requirement, we will not ask the President to request supplemental or deficiency funds for the current fiscal year.

The requirements for Fiscal Year 1964 have been carefully laid out for consideration by the Bureau of the Budget and the President, and we have no doubt that the President's budget recommendations to Congress will provide the same strong support which has characterized his actions in the past.

I am confident that the decisions which are made will support a space program which will continue to move rapidly forward, and which will enable us to achieve and maintain a space posture satisfactory to the United States.

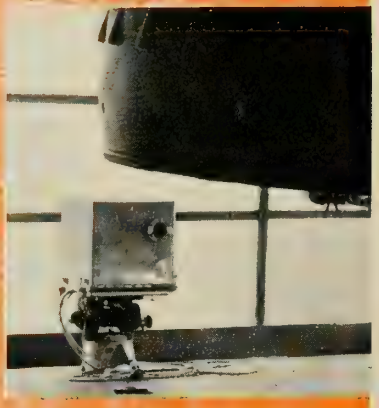
James E. Webb




# INSIDE 1,000 ERUPTING VOLCANOS!...

These are the conditions faced in placing closed-circuit TV cameras within 10 feet of the cluster of eight rocket engines used to power the SATURN space vehicle. The severe heat and vibration generated during a static firing called for a Vidicon having the highest sensitivity characteristics while being of the most rugged construction.

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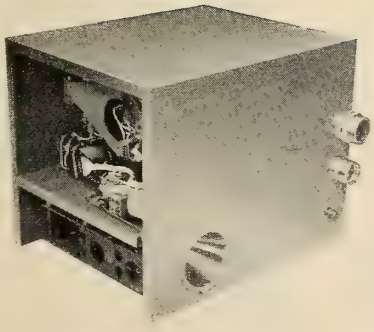


THE MOON—so called by its nearest neighbor, Earth, 238,857 miles away. Diameter: 2,160 miles. Mass: one-eighties that of the Earth. Volume: one forty-ninth. Although the moon makes a complete revolution about its neighbor less than every month, it was not until recently that Earth began its visits.

Good trip up.
Now analyzing 28 elements.
Complete report being
transmitted.
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*Lunar Gas Chromatograph—a precision analyzer in a snug, ten-inch cube—built for NASA-JPL, in conjunction with Project Surveyor.*

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The lunar chromatograph gives the first indication of the spaceborne gas chromatograph's potential. Tomorrow, the life support system for manned flight will depend even more on the precision performance of Beckman gas chromatographs. For complete information on space-age gas analysis, write to Manager, Contract Sales.

Beckman also advances space exploration in: satellite data processing, rocket propellant analysis, space capsule air monitoring, radiation analysis, and physiological monitoring.

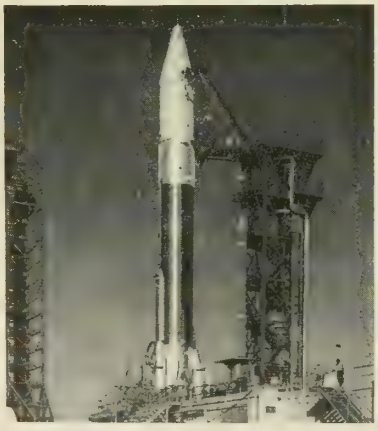
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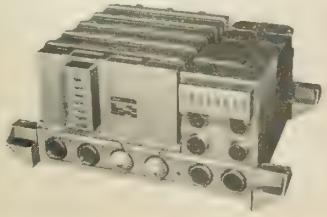
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# GENERAL PRECISION BUILDS BOTH FACE





**ON-BOARD SYSTEMS**—A Librascope computer, the first designed to guide an exploratory instrument package to a soft landing on the moon, will be carried aloft inside NASA's Atlas-Centaur spacecraft. One of the smallest and lightest general-purpose digital computers available for today's space needs.



Like the ancient Roman deity Janus, Guardian of the Gates, a space-information system has two faces. □ One is the on-board subsystem that gathers space data and performs preliminary processing. The other is the ground-based subsystem that completes the processing and displays the desired information after transmission from the spacecraft. □ Only quarter-century-mature Librascope Division General Precision has so thoroughly demonstrated competence in producing *both* on-board space-vehicle computers and large-scale ground-based data processing systems,



# F A SPACE-INFORMATION SYSTEM





under military and space contracts, and in integrating complex information systems. □ Other divisions of General Precision aid in furnishing the depth of experience in space-environment sensing, astro-navigation, vehicle- and ground-systems displays, and simulation-system management. □ Send for the story of Librascope's 25 years in information systems and latest work on advanced computing techniques and equipment.

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**GROUND-BASED SYSTEMS**—From 1963 on, U.S. global strategy will be supported by this Librascope multiple-computer system, a key part of USAF's 473L command-and-control system to be installed in the Pentagon. One of the many new large-scale Librascope computing system complexes.





**NASA**/budget

# Big Apollo

THE HIGH COST of Project *Apollo* is forcing NASA to delay existing projects and postpone development of proposed new programs.

The space agency's *Gemini,* Scientific Satellites, Lunar and Planetary, and ComSat programs have all been cut back sharply in Fiscal '63. Development of such advanced projects as the *Nova* superbooster and a manned orbiting space station have been put off from one to two years.

The immediate cause is the Kennedy Administration's decision not to ask Congress to approve a Fiscal '63 supplemental appropriation of several hundred millions of dollars for *Apollo.*

As a result, NASA is engaged in a gigantic reprograming effort. Project *Gemini* has been delayed for several months and space agency officials are considering a proposal that would cut $100 million from the program by killing the use of *Agena* target vehicles for rendezvous maneuvers.

The budgets for Scientific Satellites, Lunar and Planetary and ComSat programs have been cut back by $50 million, $20 million and $40 million respectively.

On a long-term basis, the problem is the estimated $4-billion cost of Project *Apollo* for each of the next two or three fiscal years.

This has forced NASA to delay a start on a manned orbiting space station until Fiscal '65 at the earliest, and the *Nova* booster until Fiscal '66.

The tough budgetary climate prevails despite almost certain approval of a Fiscal '64 budget of $5.5-5.6 billion and evidence that Congress and the American people are ready to support a $20-billion Project *Apollo* and a total

*STRIDE FORWARD in lunar program was firing of Douglas Saturn S-IV.*

# Pricetag Cuts Into Other Programs

***Administration decision not to ask for FY '63 supplementary funds for Apollo puts temporary crimp in Gemini, Nova and other efforts***

NASA program of almost $50 billion through this decade.

• **Jolt to Apollo**—While much of the reduction affects other programs, some NASA and Kennedy Administration officials allege that Project *Apollo* also has slipped several months.

The delay, they report, stems from a sudden jump in Fiscal '63 requirements and a concurrent Administration decision not to ask for a supplementary budget early in January.

While a supplementary request for several hundred million will be included in the Fiscal '64 budget, the officials argue that the money is needed right now and getting it six months from now will not make up for the loss in scheduling.

The funds could be used to make a major start on the Lunar Excursion Module of the *Apollo* spacecraft, initiate development of a lunar logistic vehicle, speed up work on the command and service modules of *Apollo*, and start needed construction of test stands at Mississippi Test Facility.

Top Administration officials killed the supplemental proposal. They argued that with normal Congressional consideration, it would not have been approved until the end of the fiscal year. Their counter-proposal, and the one that has been accepted by NASA, was inclusion of the funds in the Fiscal '64 budget.

• **Bargaining**—This has pushed the space agency's budget for the next fiscal period to $5.5-5.6 billion, with a possibility that it may reach $5.8 billion. Discussions are still continuing within the Kennedy Administration, however, and a final figure will not be set until early next month.

The bargaining began with NASA presenting various budget possibilities and resulting scheduling. The most grandiose called for spending a total of $6.6 billion. The Budget Bureau's first offer was slightly below $5 billion. This has been upped gradually, and the inclusion of the several hundred million in supplemental funds has raised it to the current estimate.

Officials of NASA's Manned Space Flight Office reportedly believe that they could use $4 billion in Fiscal '64. It is likely, however, that they will have to settle for $3.4 to $3.6 billion.

Of that total about $1 billion will be required for the *Apollo* spacecraft alone.

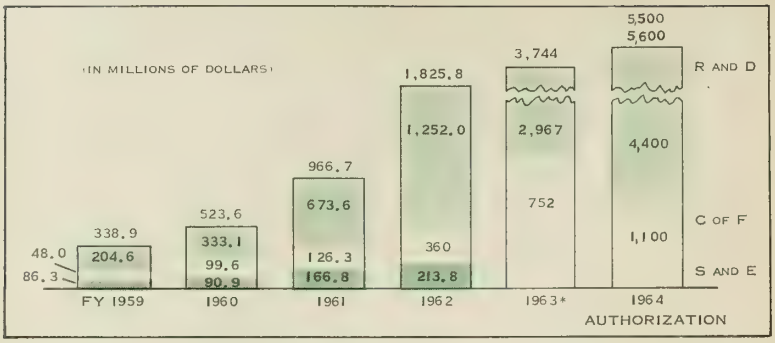
Some $200 million will be spent on the Lunar Excursion Module to speed up its production to get it ready for flight tests in the 1965-66 period. This is the spacecraft which will land the first U.S. astronauts on the Moon.

• **Big jumps**—Development costs of

**BUDGET BREAKDOWN FOR MAJOR NASA SPACECRAFT AND LAUNCH VEHICLE PROGRAMS**
**(in Millions of Dollars)**

| Program | Fiscal '62 | Fiscal '63* |
|---|---|---|
| **Apollo** | $160 | |
| **Command and Service** | — | $350-400 |
| **Lunar Excursion Module** | — | 50- 65 |
| **Gemini** | — | 230 |
| **Mercury** | 109.5 | 15 |
| **Centaur** | 224.2 | 100 |
| **Saturn C-1** | 224.1 | 250 |
| **Saturn C-1B** | — | 15- 25 |
| **Advanced Saturn** | — | 330 |
| **Tracking and Data Acquisition** | 94.8 | 158.4 |
| **F-1 engine** | 56.7 | 45- 50 |
| **RL-10 engine** | 11.1 | 25- 30 |
| **J-2 engine** | 37.8 | 40 |
| **M-1 engine** | — | $ 25- 35 |
| **Launch Vehicle Technology** | $ 27 | 31.6 |
| **Solid Propulsion** | 4.2 | 7.9 |
| **Sounding Rockets** | 8.2 | 11.9 |
| **Scout** | 3.7 | 8.9 |
| **Delta** | 2.9 | .2 |
| **Scientific Satellite** | 72.7 | 120 |
| **Lunar and Planetary Programs** | 159.9 | 239 |
| **Communication Satellites** | 94.6 | 48 |
| **Meteorological Satellite** | 18.1 | 64 |
| **Nuclear Systems** | 36 | 81.4 |
| **Electrical Propulsion** | 17.5 | 30.6 |

**Based on estimates of NASA officials following Congressional budget cuts and reprograming within the agency.*




*GROWTH of NASA budget. Construction of Facilities (C of F) and Salaries and Expenses (S and E) were included in FY '63 R&D. FY '63 figure is authorization; FY '64 figure is estimated.*

the command and service modules—under contract to North American Aviation Inc.—will jump from the Fiscal '63 figure of $350 million to about $700 million. This will cover some spacecraft procurement costs as well as the continuing R&D effort.

A massive jump in funding for the giant *Advanced Saturn* booster is also envisaged by NASA. This is the launch vehicle which will carry the *Apollo* spacecraft on its long journey to the Moon.

A doubling of the current funding level to about $700 million is in prospect. This will cover R&D and vehicle procurement for the first stage, under contract to the Boeing Corp., the second stage, being developed by North American, and the Douglas Aircraft Corp. third stage.

The funding will also cover costs of the engines which will power the multi-million-lb.-thrust booster. These include the liquid-oxygen F-1 engine for the first stage, and the rocketdyne J-2 liquid-hydrogen engine which will power the second stage.

Another $150 million will be spent on development of liquid rocket engines for the manned space flight program. In addition to the *Advanced Saturn* engines, some of the money will be used for the 1.2-million-lb.-thrust M-1 liquid-hydrogen engine for *Nova*, and the RL-10 and H-1 engines of the *Saturn C-1*. Funding for each of the engines will be roughly the same as in Fiscal '63, although a slight jump in M-1 funds is possible.

A major start will also be made on procurement of *Saturn C-1* launch vehicles for *Apollo* orbital flights in 1964-65. This is expected to cost $100 million, with another $60 million for R&D on the 1.5-million-lb.-thrust booster.

• **Gemini outlook**—Project *Gemini*—the two-man spaceflight series designed to prove rendezvous in space—is currently beset by a program re-evaluation, but officials estimate it will cost about $300 million in fiscal 1964. Also undecided is what role, if any the Air Force will play in the program.

A decision on the program will be made in the next couple of weeks. The major change which NASA headquarters is considering calls for dropping the use of the *Agena B* target vehicle during rendezvous. Besides the saving in *Atlas* and *Agena* vehicles, the switch would kill the need for two launch pads for the program. Instead, *Gemini* would rendezvous with a satellite placed in orbit after riding piggyback on the spacecraft during launch.

The Air Force has presented NASA with a proposal under which it would take over some of the program's later flights. Its argument is that it will help NASA with its funding problems. NASA officials are cool to the idea. Instead, they believe the better approach would be for the Air Force to get DOD approval of its own *Gemini* program. This is the so-called *Blue Gemini* series.

• **Other Apollo Fiscal '64 items**—New construction at the Mississippi Test Facility, the Launch Operations Center, Marshall Space Flight Center and the Manned Spacecraft and other centers probably will require $600 to $800 million.

Funds for the lunar logistic vehicle—if it is approved—probably will be in the neighborhood of $150 million. Tracking, in-house and industry studies of future programs, advanced research and technology will account for the remainder of the funds.

The remainder of the NASA space program will thus have about $2 billion of the total Fiscal '64 budget. Almost half is likely to be spent for launch vehicles, satellites, and spacecraft for its unmanned scientific exploration programs.

The most expensive will be the lunar and planetary programs. The budget in this area may hit $400 million. Other programs which are likely to show an increase are scientific satellites and meteorological programs. The extent of the ComSat programs will remain clouded until the role of the new commercial communications satellite corporation is ascertained.

While NASA officials continue to declare that the space agency plans a balanced program, it is clear that if the costs of *Apollo* are such that the budget squeeze gets tighter, the unmanned area will be reduced as it was in Fiscal '63. For Fiscal '64, it has already cast a shadow over the development of such projects as *Voyager* and passive communications satellites.

• **Future trend**—While NASA is currently delaying and postponing certain programs, there is a vast number of projects which will provide future contracting opportunities for missile/space firms.

The current projection by NASA officials is that the space agency budget will rise to about $6.5 billion in Fiscal '65. From that point through the end of the decade, it should run at a $6-7-billion annual rate. This will push total spending for space in this decade to about $50 billion and provide the funds needed for the lunar landing program.

It will also allow NASA to phase in new projects.

The Lunar Logistics Vehicle—which NASA plans as a 20,000-lb. payload on the *Advanced Saturn* booster—will be funded late in Fiscal '63 or in Fiscal '64. Some thought also is being given to using the Lunar Excursion Module of the *Apollo* spacecraft as an early lunar supply vehicle.

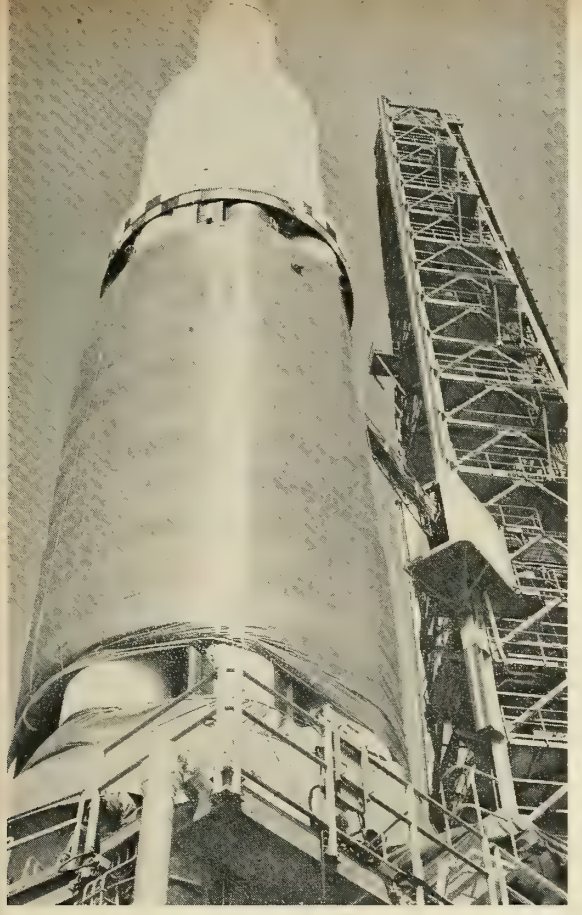
In Fiscal '65, NASA currently plans to begin development of a small—perhaps four-man—orbiting space station. It would serve as a mission module for either the *Apollo* or the *Gemini* craft.

In the Fiscal '66-'67 period, *Nova* and a large erectable space station may be started. NASA now considers *Nova* a post-*Apollo* vehicle which will be used for manned interplanetary missions in the mid-1970's.

It has now also been placed below the orbiting space station in the NASA priority list. The earliest date for hardware development now is Fiscal '66 at the earliest—and even the first efforts may be funded at a low level. How heavily it is funded will depend upon how soon a national decision is made to support manned flights to Mars and Venus.

Some major unmanned programs which will be initiated include the *Aeros* weather satellite, *Voyager*, *Surveyor* lunar orbiter, and many new planet and solar probes.

One major consideration will rule the rate and continuity of the space-agency budget buildup. This is usually put politely as the "international situation," but it is primarily how the U.S. stands in its race to the Moon against Russia. Major new Soviet space feats could still force a crash program. ⠿



*SATURN C-1 poised on Cape Canaveral pad before Nov. 16 launch, the third straight success for the nation's mightiest launch vehicle.*

NASA/procurement

# New Emphasis Given to Incentive Contracting

***Three-phase contractor source-selection procedure to cut industry proposal costs***

NASA IS REVAMPING its procurement procedures to reduce industry proposal costs and put new emphasis on the use of incentive-type contracts.

The space agency has adopted a Defense Dept. circular which directs procurement officials to use incentives rather than cost-plus-fixed-fee contracts whenever possible.

To implement the rule, NASA will shortly initiate a vast training program for contracting and technical personnel on the use of incentives.

Another proposed change calls for a three-phase contractor source-selection procedure, which officials say will sharply reduce the cost of industry proposals.

Under the plan, NASA in certain instances, would first ask 10 or 12 companies to submit what it calls a business proposal. Firms would be asked to list current facilities, whether new ones would be required to perform the contract, key personnel and present work load.

After evaluation of the proposals, two or three firms would be selected to present detailed technical bids. A third step being considered would permit the firms to submit their cost estimates 10 days or two weeks later.

• **Committee consensus**—The three-phase proposal and the incentive contract program are the major results of a special in-house space agency committee charged with improving source-selection methods and contracting procedures.

The present timetable calls for submission of the committee's reports to Administrator James E. Webb by Jan. 1.

Other major committee recommendations which are being considered:

—Limiting the size of proposals submitted by industry during procurement actions. This would vary—depending upon the size of the project—but it would primarily set a ceiling on the number of pages in the proposal.

—Forbidding firms from submitting working models as part of a bid or proposal.

—Giving the space agency—for the first time—an active role in the determination of a firm's negotiated overhead allowances and independent research costs.

—Assuming control over additional facilities at a contractor's plant paid for by NASA. Currently, NASA lets DOD's contract representatives at the plant handle this function, but officials now feel better control over costs would be permitted if the space agency took over the job.

• **No flood of contracts** — Space agency officials do not expect the new emphasis on incentive contracts—under which contractors can earn an extra fee for superior performance—to result in a rash of contracts being awarded.

They point out that the very nature of NASA's operations precludes it. That is, most of the agency's procurement is in the research and development area, where there is no standard on which to base a measurement of high performance.

The officials intend, however, to award as many incentive contracts as possible. They say the opportunities will grow as more and more experience is gained in their use. Five incentive contracts have been awarded recently, and procurement officials are considering several more.

The DOD directive has been re-

leased as NASA Circular 242. It places the responsibility for looking into the ways and means of increasing the use of incentives.

Its most important section rates use of incentives in second place in order of contract preference—after fixed-fee awards, but before cost-plus-fixed-fee agreements. Fixed-fee contracts, however, are almost never awarded in R&D work.

The circular also provides against irresponsible use of incentives. Under its provisions, centers wishing to award such a contract must first get the approval of the headquarters procurement office.

• **Competition still welcomed**—Officials hasten to declare that the proposed changes in the area of source selection will not lessen competition for NASA procurement.

"We still intend to have competition and interested firms will always have an opportunity to bid," one official said.

The changes are designed, he added, to reduce the company's cost of submitting bids. By delaying the company's cost proposal, the agency hopes to get more reliable estimates.

At the same time, NASA expects that changes in negotiated overhead and facility management will give it more control over costs and its contracts. In the past, the space agency has primarily relied on DOD to perform the function.

Under the procedure, DOD officials decide at the beginning of each fiscal year just what a defense or missile/space firm's overhead allowance is to be. It also decides just how much of the company's independent research the government should pay for. These costs are then included in company bids and contracts as allowable costs.

NASA now intends to make itself a party to these negotiations. The same situation prevails in the facility area.

Currently, if a contractor needs a new facility for its NASA contracts, NASA pays for it. It is usually managed by DOD, however, under facility contracts which the Pentagon has with most major firms. NASA also intends to do more of the management in this area.

• **Two standbys** — Despite the changes in various procedures, NASA will not make any major revision of the two types of contracts used most.

The fixed-price contract is the most frequently used, and is preferred for the procurement of goods and services that can be clearly described. This type of contract can be used for either formally advertised bids or negotiated procurement. There are also occasions when a fixed-price or "lump-sum" contract may be employed for the support of research.

In arranging a fixed-price contract, provision may be made for special situations. An example might be the use of price redetermination—when the performance of the contract may involve large contingencies or uncertainties in cost, such as first-time production runs.

The cost-type contract is often used when there are a number of "unknowns" in a program, such as research and development. For example, NASA may use a cost-type contract to support either basic or applied research which has a fixed objective and a deadline for completion. A cost-type contract would, in such circumstances, protect against assumption of unwarranted financial risks due to technical uncertainties. ■

## Directory of NASA Procurement Organization

| Center | Address | Contracting Areas | Procurement Chief | Small Business Advisor | Contracting Limitations* |
|---|---|---|---|---|---|
| NASA Headquarters | Washington 25, D.C. | Overall management and administration of agency contracting procedures | Ernest W. Brackett, Director | Jacob M. Roey | |
| Headquarters Procurement Br. | Washington 25, D.C. | R&D study contracts, supplies | Albert A. Clagett | E. W. Quintrell | $500,000 |
| Ames | Moffett Field, Calif. | R&D | A. S. Hertzog | Donald E. Davis | $100,000 |
| Langley | Langley Field, Va. | R&D | Sherwood L. Butler | Joseph F. Braig | $500,000 |
| Goddard | Greenbelt, Md. | Scientific satellites and tracking systems | Gordon H. Tyler | Harry T. O'Toole | $500,000 |
| Jet Propulsion Lab. | Pasadena, Calif. | Unmanned lunar & planetary program | Ted Candee | G. R. Lawrence | No Limitation |
| Western Operations | Santa Monica, Calif. | Manager and monitor contracts for West Coast NASA installations | Earle Sample | Alex Mirosov | $1 million |
| Flight Research | Edwards, Calif. | X-15 and R&D | Morris E. Bowling | Lloyd J. Walsh | $100,000 |
| Wallops | Wallops Island, Va. | Launch complex for Scout and Sounding Rocket Programs | Louis T. Birch | Robert H. Bradford | $100,000 |
| Marshall | Huntsville, Ala. | Large launch vehicles | Wilbur S. Davis | James E. Morrison | $1 million |
| Lewis | Cleveland, Ohio | Propulsion | John Biggs | Norman C. Prahst | $500,000 |
| Launch Operations | Titusville, Fla. | Launch complexes, R&D for launch facilities and fuel storage | Gerard A. Michaud | Carl J. Dahl | $250,000 |
| Manned Spacecraft Center | Houston, Tex. | Manned spacecraft | David W. Lang, Jr. | Harold Christian | $1 million |
| Space Nuclear Propulsion Off. | Germantown, Md. | Nuclear rockets and nuclear systems | George Kimble | None | X |
| Northeastern Contracting Off. | Boston, Mass. | Industry-university relationships, contract management | Franklin W. Phillips, Dir. | None | X |
| Michoud | New Orleans, La. | Launch vehicle production | None selected | None selected | X |

* Limit after which Headquarters approval is necessary.
X—not applicable

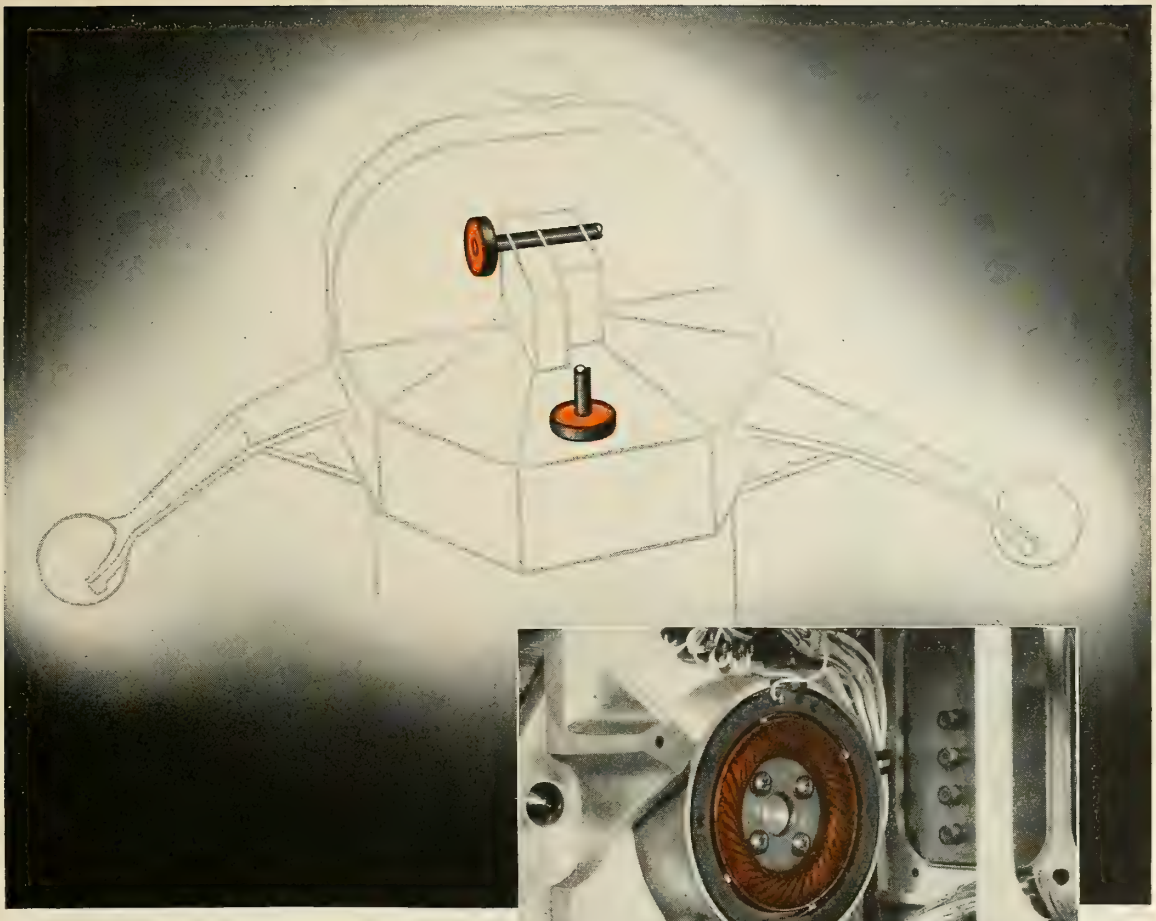


*Photo — Courtesy of Ball Brothers Research Corporation*

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**TEST ENGINEERING (BS, MS).** Build and analyze static firing test stands and associated hardware. Recommend range handling and operating equipment including environmental test.

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Write in confidence to: Mr. W. D. Linkenhoker, Dept. 3L-4

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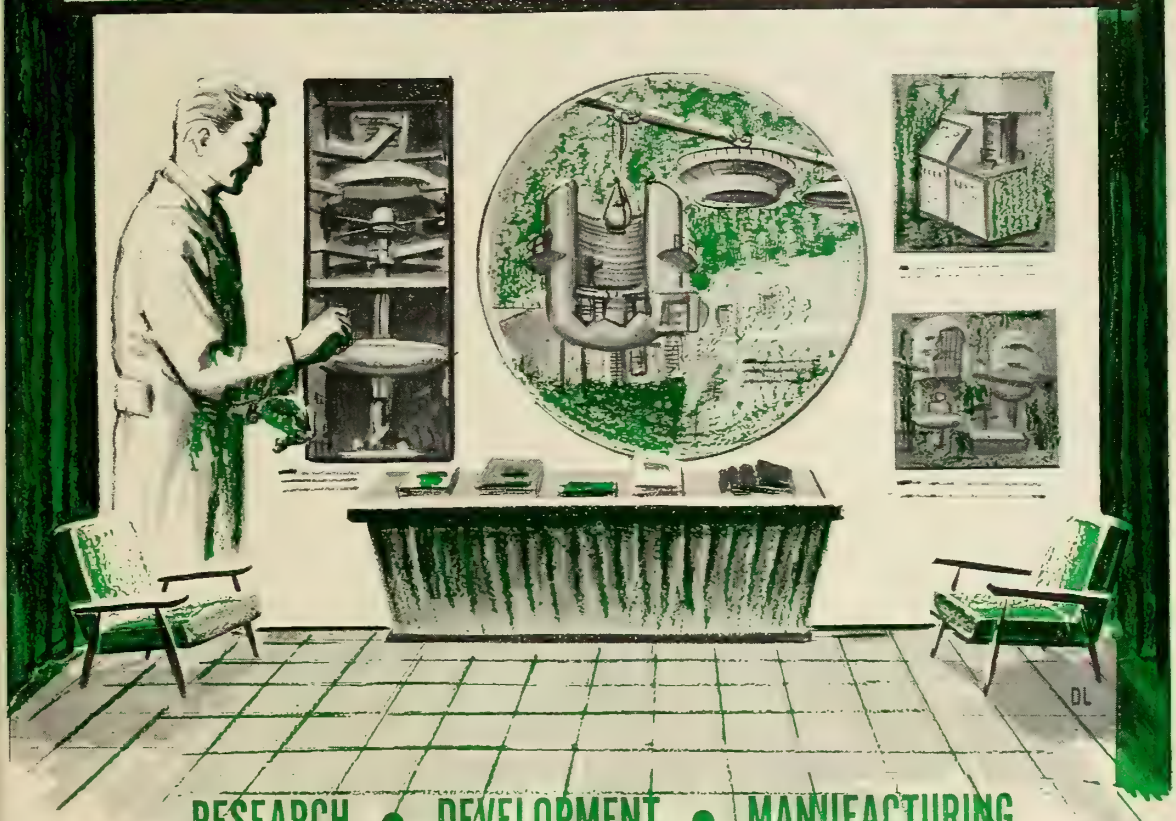
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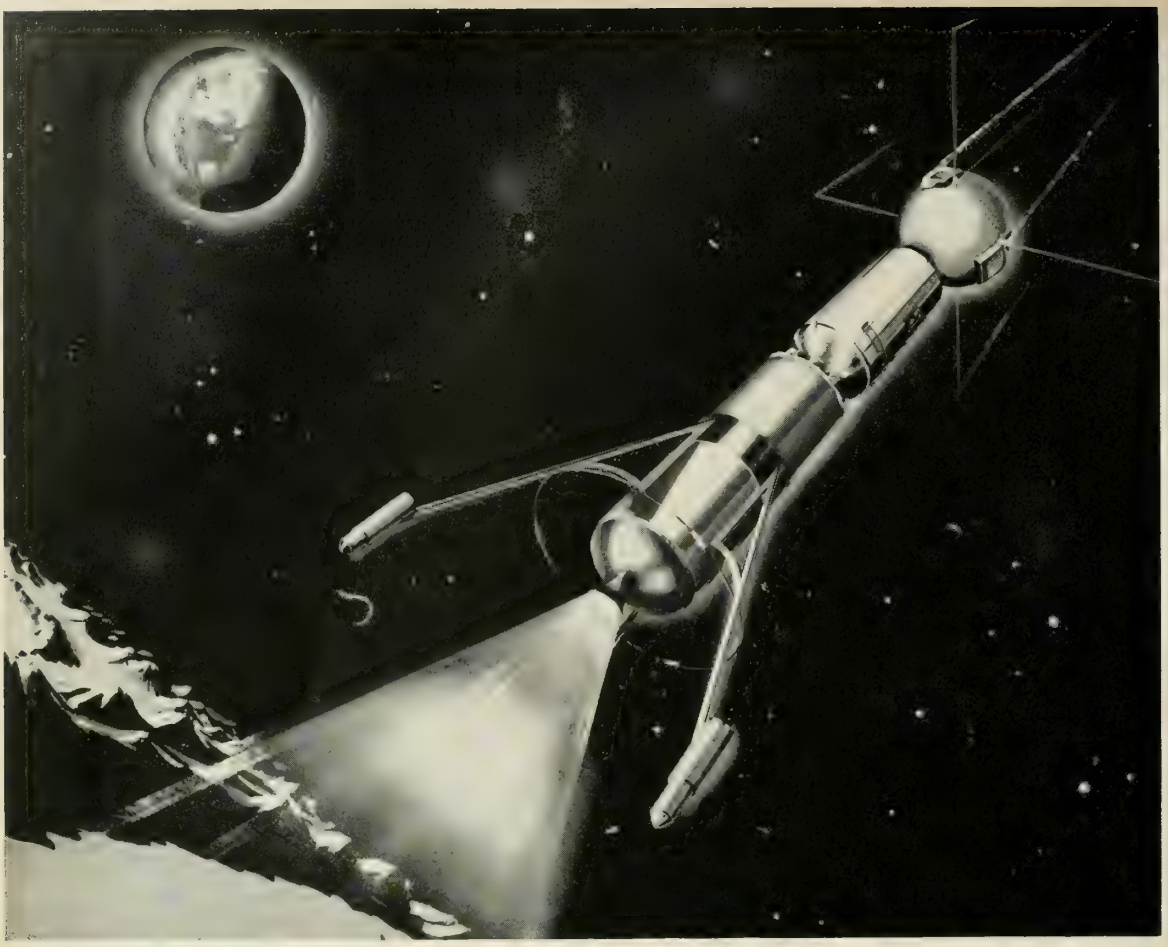
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# GUIDE TO SPACE PROGRAMS





**NASA**/apollo

# LEM Decision Speeds Lunar Program

***Signing of detailed contract with Grumman expected in middle of December; first subcontracts should be let early next year***

AWARD of the Lunar Excursion Module contract to Grumman Aircraft Engineering Corp. marks final commitment of the $20-billion Project *Apollo* program to lunar-orbital rendezvous.

Some formidable technical problems still remain before a pair of U.S. astronauts step on the lunar surface late in this decade. Nevertheless, Administration endorsement of the LOR decision means the program can now move ahead at full speed in the race to beat the Russians to the Moon.

Last week, Grumman President E. Clinton Towl led the first of a 60-man team of technical and administrative personnel into the Manned Spacecraft Center at Houston to begin negotiation with NASA on LEM details.

Signing of a detailed LEM contract is expected in mid-December. First subcontract awards in this area are likely early in 1963.

Grumman thus becomes the third major partner in a smoothly functioning team which already includes North American Aviation and NASA.

President Harrison Storms of NAA's Space and Information Systems Division, prime contractor for the *Apollo* Command and Service modules, puts it this way: "Our team and the NASA team finally are beginning to work closely together. It's becoming a one-team approach. It always takes a while to get everyone oriented. But you can see that they are moving as a unit now."

Grumman will be welded strongly into that unit. As Storms sees it, the delay in award of the LEM contract may have simplified the management problem. Linking Grumman to an already-existing NASA-NAA team will be easier than it would have been to initially meld three separate teams.

• **NAA looked ahead** — North American already is well down the road on design changes required in the Command and Service modules by the LOR approach. Without awaiting the LEM award, NAA began the necessary changes last July when NASA announced its initial LOR decision.

Some major problems still must be solved. Not the least of these is the question of how the LEM craft will be shifted in space from its launch position beneath the Service Module to a frontal connection with the Command Module.

There are several possible solutions:

• The lunar bug might be disconnected in flight from the other modules,

which then would be turned around to dock with it.

- LEM could be moved forward by mechanical arms.
- It could be towed around on a line, in much the same way a dinghy is walked around a yacht.

This transfer must be made early in the lunar trip. LEM in its launch position is in the way of the thrust units which will be employed for mid-course correction and also injection into lunar orbit.

Ample time also must be provided for the astronauts to pre-flight the module before lunar descent.

Although final details of the bug still are to be worked out, its general configuration is known. LEM will look not unlike a helicopter, with good visibility for maneuvering close to the lunar surface. Ten feet in diameter, it will stand some 10 ft. high on its five spindly legs. It will leave the lower, landing segment behind on launch from the Moon to rendezvous with the *Apollo* spacecraft orbiting above.

Overall initial weight will be about 12 tons. Launch weight from the Moon will be about four Earth-tons. Two astronauts will ride the bug to the lunar surface while a third remains in orbit with the Command and Service modules.

LEM will be left in lunar orbit when the astronauts return to Earth.

One of the intriguing design factors in LEM is the fact that it will be the first true spacecraft in the sense that it will operate only in space. It will be subjected to Earth g-loads only on launch.

Changes have been necessary in both the Command and Service modules as a result of the LOR decision. Among these:

- Size of the Service Module has increased slightly to a length of 155 in. (without adapter). This results from the need to carry the additional weight of the bug, although there was some tradeoff due to elimination of the Service Module landing requirement.
- Size of radiators for environmental control has been somewhat reduced.
- Insulation requirements of the two large modules are less.
- Requirements for repeated entry and exit from the Command Module are reduced.
- Fixed radiators will be employed in place of extendable arms, a simplification permitted by reduction of g-loading of the Service Module. This, incidentally, is true for a great deal of Command and Service module equipment which no longer must be designed to withstand landing shocks.
- Empty weight of both the Command and Service modules has been reduced.
- Two adapters to the *Saturn* launch vehicle now will be built, one for use when the bug is carried and one to be employed when it is not.
- **LOR ramifications** — Extensive studies are underway to determine the wide-ranging effect of the LOR decision. Requirements must be drawn up for equipment for rendezvous in lunar orbit, fuel requirements for both the bug and the orbiting spacecraft must be determined.

"This thing is not simple," asserts Charles Feltz, NAA chief engineer for Project *Apollo,* in one of history's great engineering understatements. But he says the project has run into no more design and engineering problems than might be expected at this stage.

Analytical changes have been even more extensive than design changes. Mission requirements have increased to include Earth orbit, trans-lunar, lunar orbit, lunar landing and takeoff, lunar rendezvous, return, re-entry and recovery phases. Abort planning also has been undertaken for all phases.

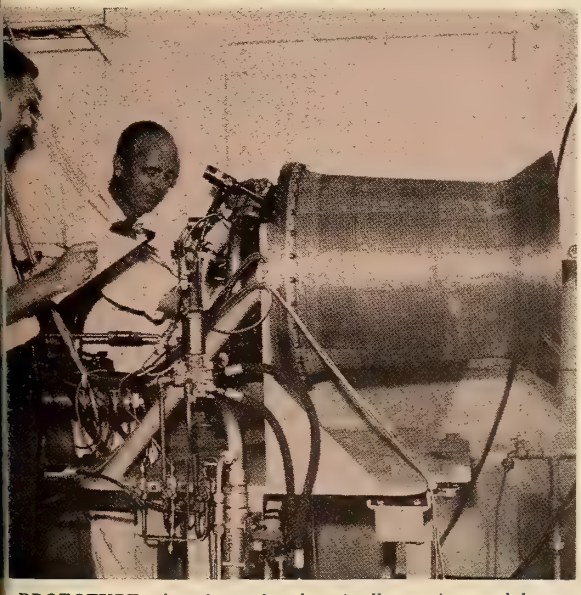
North American is well along on tooling and building of boilerplate models. First actual *Apollo* hardware will begin to take shape at the Downey, Calif., plant after the first of the year.

Some subcontractors are even further down the road. Aerojet-General for example, already has chalked up several successful firings of the prototype propulsion unit for the *Apollo* spacecraft.

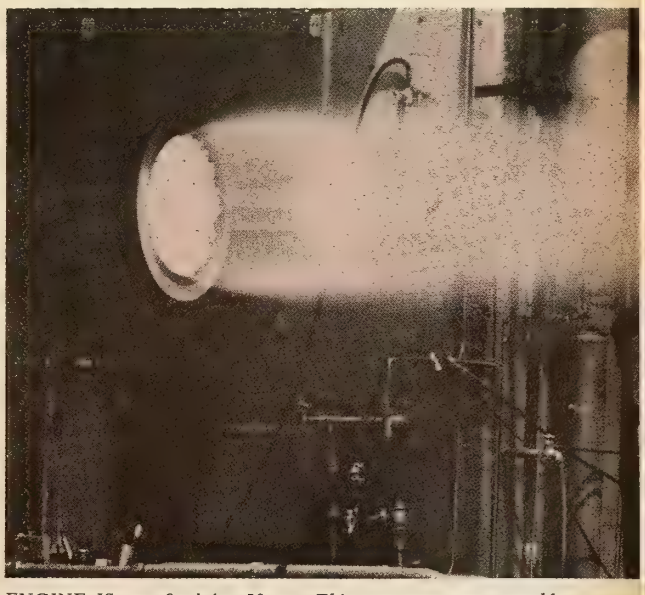
This is the engine which will be used for mid-course guidance, lunar injection and ejection into an Earth-return trajectory. Tests have been aimed at establishing re-start capability, reliability and long-duration burning.

Aerojet has fired a full-scale prototype engine with an ablative thrust-chamber assembly on runs of up to 50 sec. A smaller sub-scale engine successfully completed a test run of 1020 sec. duration.

This is but one of many subcon-



*PROTOTYPE of main engine for Apollo service module gets final inspection before firing at Aerojet-General, Azusa, Calif.*



*ENGINE IS test fired for 50 sec. This prototype uses storable liquid propellants and an ablative thrust chamber assembly.*

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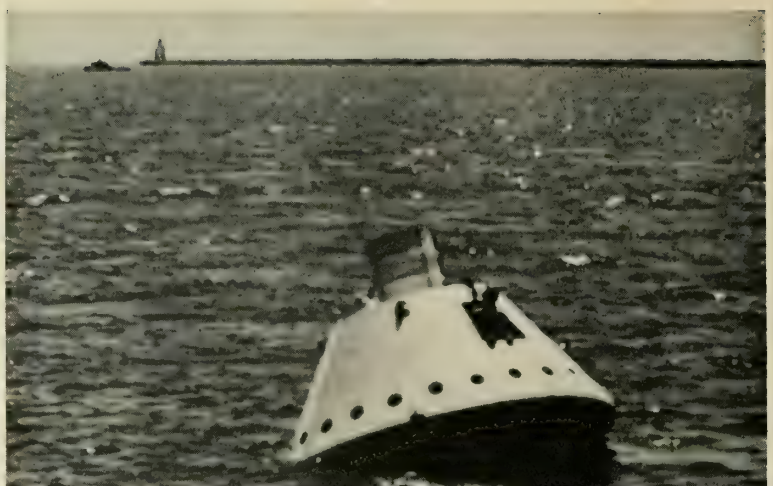
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*FULL-SCALE Apollo boilerplate test model undergoes flotation tests in Pacific Ocean near Los Angeles. From here, model went to NASA's Manned Spacecraft Center, Houston, Tex., for additional testing. Manned flight is scheduled for late 1964.*

tracted units which must be phased into a complex *Apollo* time schedule.

• **PERT system applied**—The well-accepted PERT management technique is being used throughout the project. This network is just beginning to function and SIDS President Storms says it still is too early to tell what PERT will mean to the project. He is wary of a tendency to over-credit PERT.

"PERT only says where the troubles are," he points out. "People take care of the troubles."

The recent cost reduction drive on *Apollo* has had a healthy effect on the program, in Storms' view. "It's good that these things occur. It's good business management."

This was confirmed by director Robert Gilruth of the Manned Spacecraft Center, who told MISSILES AND ROCKETS that *Apollo* schedules have not been affected by the NASA financial re-programing. Some luxuries are coming out of the project—some simulation and test programs are being cut, for example—but the schedule still calls for *Little Joe* flights with the *Apollo* spacecraft in 1963 and the first manned flight in late 1964, using the *Saturn C-1B*.

The budget for LEM in fiscal '63 is between $45 and $60 million. This will expanded to more than $180 million in FY '64. Total *Apollo* funding in the FY '63 budget is between $350 and $400 million. It will total more than $800 million in FY '64.

The protracted scientific argument over the feasibility of lunar orbital rendezvous in the *Apollo* program has not unduly delayed the project, according to those close to it.

Any hardware delay incurred from the shift to LOR took place, for the most part, before NASA's decision last July. This was early enough in the program so that it did not represent a major problem. LEM itself is not the pacing item in the project.

• **LOR advantages**—NASA feasibility studies indicated that all three methods of approach to the Moon were feasible—direct ascent, earth orbital rendezvous and lunar rendezvous. It thus came to a choice of which offered the greatest advantages.

Apollo boss D. Brainerd Holmes points out these for LOR:

• It is fastest. At this stage, LOR offers a 6 to 15 month gain over Earth rendezvous and one year over direct ascent. The possibility exists of an 18-month time lag if a change to one of the other methods is forced now or later.

• It is cheapest. Holmes estimates that the lunar landing can be achieved with LOR some 10 to 15% cheaper than Earth orbital rendezvous—a saving of more than $2 billion in the program. This is particularly important in view of the current economy wave in NASA programs.

• It separates from an engineering standpoint the two toughest assignments in the program. Grumman can concern itself with the problem of lunar descent and ascent, while North American tackles the design for re-entry and Earth landing. Both of the other methods would require engineering a capability for both into a single vehicle.

Some advantage has also been found organizationally in the LOR approach. The interfaces have worked out cleanly.

Another factor affecting the LOR decision was the realization that direct

ascent with the *Saturn C-5* and a smaller capsule was too marginal from a weight standpoint to allow any growth potential to meet possible engineering emergencies.

Use of cryogenics would have been mandatory for direct ascent. With the LOR approach, storables can be used with a margin for growth. If necessary, a shift can be made to cryogenics.

On mission success and safety probabilities, LOR scored equal with the other methods and with a good chance of bettering the odds.

LOR also offered the advantage of a step-at-a-time approach to the lunar mission. After Earth orbital efforts have been successful, the spacecraft then can embark on a circumlunar mission. With this accomplished, injection into a lunar orbit and return to Earth can be carried out on a later mission. This can be followed by missions in which LEM will be landed by remote control. After each of these steps has been accomplished, a team of astronauts can land.

• **Apollo's versatility** — LOR also has another attraction. NASA already is considering use of LEM as a substitute for the *Lunar Logistics Vehicle*. It could be employed for landing supplies on the Moon in missions before the manned landing.

NASA also is considering the possibility that it might use the *Apollo* program as a cheap route to fulfilling its desire for a manned space station. This would be accomplished by using empty *Apollo* service modules for the station.

Holmes believes the *Apollo* mission can be accomplished within the original estimate of $20 billion. He emphasizes, however, that this is simply for a single lunar landing and return. It does not include cost of a follow-on lunar program or some of the other missions it might be desirable to accomplish enroute to the achievement of a lunar landing—such as development of an orbital space station or the *Nova* vehicle.

The *Apollo* Command and Service modules are being designed so that it will be a relatively simple matter to reengineer them for direct ascent landings on the Moon should later launch vehicle growth make this desirable. Such landings are not yet within the scope of the $20 billion program.

Technical solutions cannot yet be sought for some of the problems *Apollo* will face. In such areas as radiation and meteorite hazards, not enough is known to provide sufficient design criteria. Much of the information of this type will have to come from the *Gemini* program—one reason *Apollo* planners are concerned with the effect of budget cuts on Project *Gemini*. ⌗


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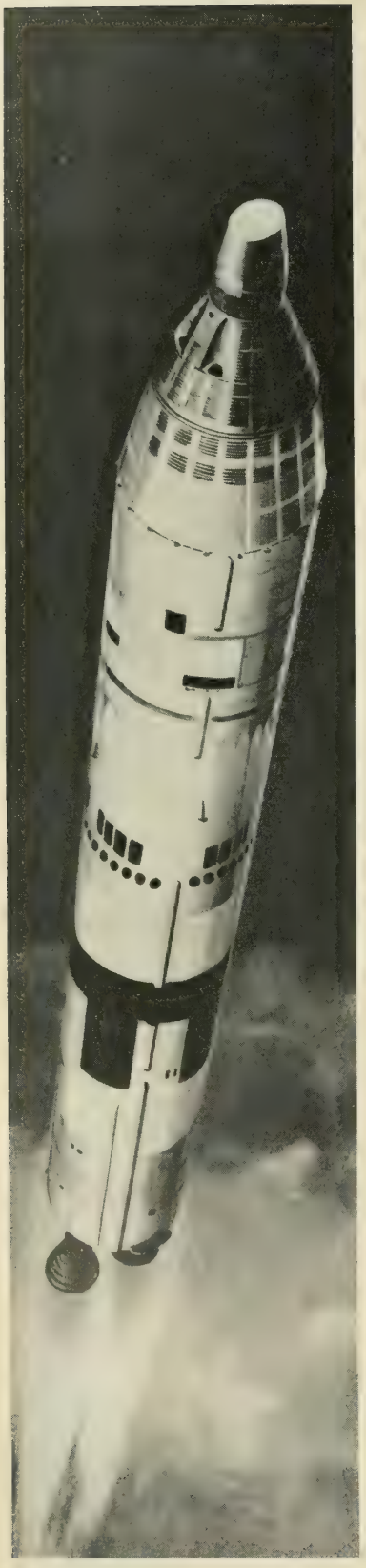
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**NASA**/gemini and mercury

# Gemini Program Cut Back In Funds, Lengthened

***Initial funding cannibalized by Apollo; Agena D may be dropped; Air Force presses for share in later stages***

REPROGRAMING of NASA funds has converted Project *Gemini* from an 18-month to a 22-to-24-month program. Also in prospect is at least one major change in technical approach.

Contractor estimates for *Gemini* for Fiscal Year 1964 totalled some $300 million. This has now been cut to $230 million.

As Director Robert Gilruth of NASA's Manned Spacecraft Center points out, the money to keep *Apollo* on schedule had to come from somewhere, and it was taken out of the budget for *Gemini*—which he describes as an "interim" program.

• **Agena may go**—Use of *Agena D* as a rendezvous vehicle in the *Gemini* program is in question; whether it will be dropped or retained is to be decided before the year ends. Some quarters in NASA are proposing rendezvous with a pod carried into space aboard the *Gemini* launch vehicle and inserted into a similar orbit for use in practicing docking techniques.

High NASA officials reportedly were skeptical of the plan at first, but now seem more receptive. There is a distinct possibility therefore that the *Agena* portion of the program will be completely discarded, thus saving an estimated $100 million in program funds. The savings would be realized through reduced launches required, elimination of need to modify a launch complex at Cape Canaveral, and similar hardware and development reductions.

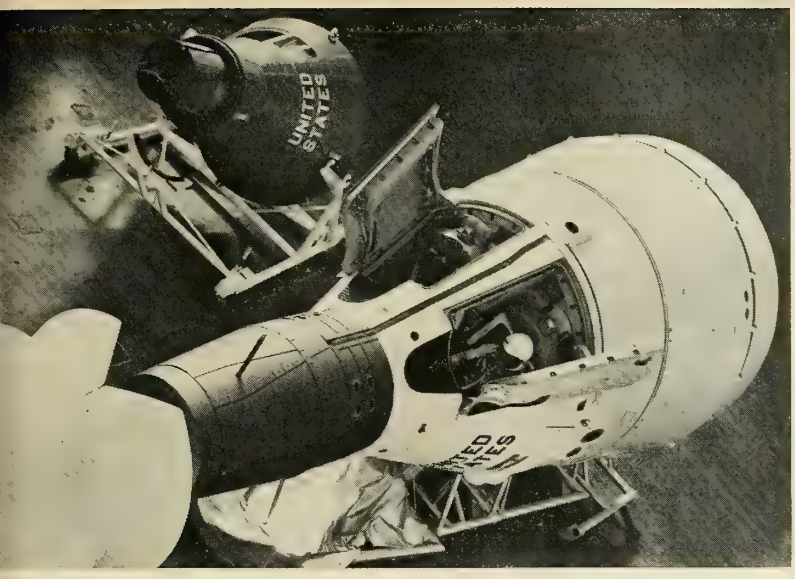
Proponents of the pod idea say it would have the same docking collar as the *Agena-D* and that this is the prime requisite for docking practice. A pod would be a simpler target vehicle, but would have an attitude control system and, to some extent, its own propulsion system.

An informed source said the prime objectives of the *Gemini* program are to demonstrate rendezvous and docking techniques, orbital maneuvering capability and the paraglider system. "We asked ourselves what the *Agena D* adds to our ability to carry out these objectives, and the answer was: 'very little,'" he said, "and if we want to demonstrate dual-launch capability, all we have to do is launch a useful scientific satellite, follow it with the *Gemini* within our allowable 'window,' and have the astronauts bring back the information."

Even the pod might carry some useful scientific instrumentation or radiation emulsion packages which could be returned to Earth by the *Gemini* crew, he added, pointing out that such an arrangement would be used only as a bonus to the original objective of practicing the docking techniques.

One important factor which may influence the decision on *Agena* is the Air Force's desire to retain it in the program. AF wants *Agena* in the program because of its propulsion capability, which would allow greater latitude for future satellite-inspection missions. One observer commented, however, that the Air Force could attain this objective by getting its own, *"Blue Gemini"* program and using the *Agena D* as NASA has been planning to use it.

• **Added flexibility** — Orbital maneuvering of the *Gemini* would be enhanced by addition of the *Agena D* propulsion system to *Gemini's* own. Electrical connections made at time of docking will enable *Gemini* crewmen to start *Agena's* engine and use it for




*RELATIVE SIZES of Mercury, Gemini and Agena-D. Two-hatch Gemini is in simulated docking approach to collar of Agena, which engages Gemini guide bar in V-notch.*

orbit alterations. However, some sources indicate that this increased capability, though useful to the Air Force, is not of sufficient value to NASA.

With its own propulsion system, *Gemini* can alter its orbital inclination by 0.3 degree, using on-board fuel, and it can add or subtract 700 fps from its orbital velocity. With *Agena,* orbital velocity change increases to 4200 fps.

"While these figures may make it seem that *Agena* is a great boon to our mission, it actually is not that important," said a NASA official. He noted that *Gemini* could take a ±10 degree roll misalignment on *Agena* rendezvous, as well as an overall 10-in. axial misalignment. The *Agena-D* would be turned 180 degrees in orbit for rendezvous, since the docking collar is on its front end, and the rendezvous would be made with the nose of *Gemini.* All pre-rendezvous maneuvering would be made with *Gemini* propulsion, unless a major orbital difference forced use of the *Agena* engine for corrections.

AF has already proposed taking over some of the later *Gemini* missions, but NASA officials are presently cool to this idea (M/R, Nov. 19, p. 18).

• **Stay for Mercury** — McDonnell-built *Gemini's* highly successful predecessor, *Mercury,* seems destined to carry out at least one and possibly two more manned missions before settling into the history books. *MA-9,* slated for an April launch, will carry Astronaut L. Gordon Cooper, Jr., into orbit for about one day for further manned spaceflight data gathering.

*Mercury* could have still another manned launching to take up some of the time before *Gemini* launches with useful developmental work.

The possibility also exists that McDonnell's *Mercury* capsules will be used after the final manned shot for the long-duration orbitting of chimps and other animals for biomedical research. This program, however, depends on the remaining manned launches, of which NASA still has four more officially scheduled, although some sources doubt that more than two will be carried out.

Intervening launches of *Mercury* capsules until *Gemini* gets under way are bound to be determined by the extent to which *Gemini* slips.

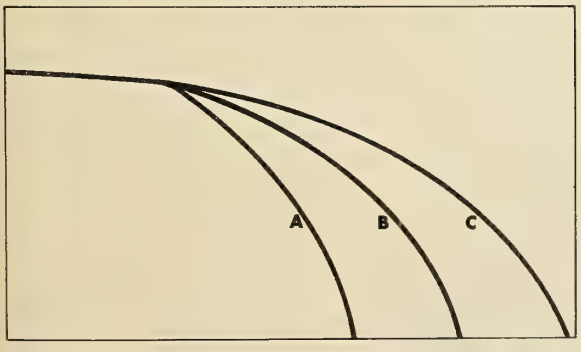
The new program calls for first orbital launch with crew early in 1964. The only ballistic launch, now set for late 1963, was originally set for early next summer. It will be an unmanned parachute-recovery flight without paraglider.

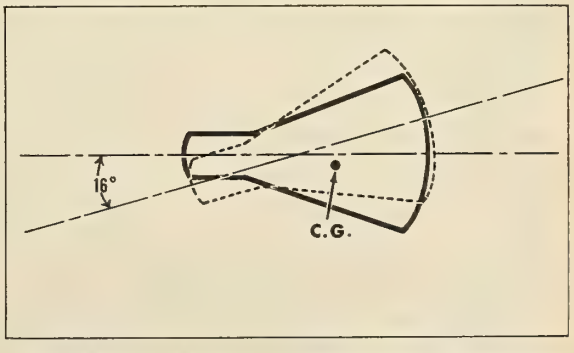
Under its current authorization, NASA's Manned Spacecraft Center at Houston has assignment only to demonstrate rendezvous in space between *Gemini* and another craft.

"But once we demonstrate it, we expect to use it," said Andre Meyer, MSC Chief of Project Administration for *Gemini.* He said that before the program is over, and as it expands in scope, it is probable that spending will total more than initial estimates of $700 million. The stretch-out also means that the program will cost more, according to Meyer, since it will require the same staff for a longer period of time.

• **Cutting back**—One result of the stretch-out is that workers are already being laid off at Houston and Baltimore, where *Titan II Gemini* boosters are being turned out. The Martin Company is reported to have laid off about 800 workers on the program. Meyer said there has been no cutback in numbers of spacecraft or boost vehicles being purchased. This applies, as of now, to both the *Gemini* and *Agena-D* vehicles and their respective *Atlas* and *Titan II* boosters.

NASA has ordered 12 flight cap-



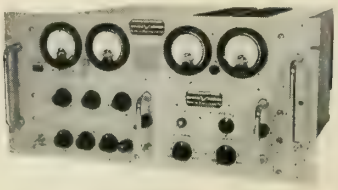

*VARIABLE re-entry trajectory (left) of Gemini, controlled by amount of roll around longitudinal axis of capsule. Astronaut can roll 100% of time, thus negating lift component and landing short, or not roll at all and extend trajectory. By varying roll, he can land anywhere in between. Below 40,000 ft., paraglider is used. Capsule, with offset CG developing roll moment, enters with 16-degree angle of attack. Mercury re-entry attitude is shown as solid line, Gemini as dotted line, with blunt end forward.*

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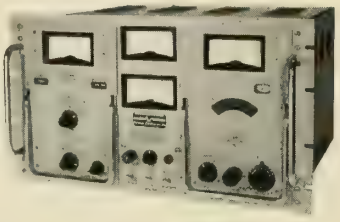
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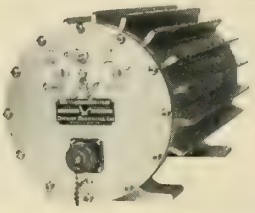
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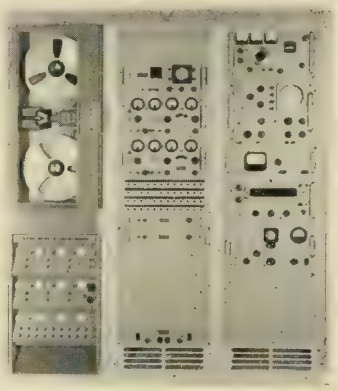
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sules and 15 boosters for the *Gemini* program, with plans to refurbish three capsules and re-use them after recovery. With this plan, NASA has the capability of 14 manned orbital flights with the 12 capsules.

Since the reprograming, MSC has trimmed *Gemini* to what Meyer calls a "Model A" version, compared with the earlier, fancier model. Some planned testing and documentation have been cut and frills have been reduced in the spacecraft, but Meyer said nothing has been deleted that will reduce reliability or "seriously" affect the schedule.

He noted that the *Gemini* program thus far is going along more smoothly than did *Mercury* at the same phase of development, and that no major engineering problems exist. Successful flights have been made with half-scale paraglider and *Gemini* mockups during which 360-degree turns were completed while the model was flown and landed by remote control.

Full-scale tests of the paraglider with a boilerplate mockup are due to start in December. Present tests, conducted at Edwards AFB, Calif., have been carried out using helicopter towing techniques, and future full-scale tests will involve high-altitude drops from an Air Force C-130 transport. Later the astronauts will practice *Gemini* landings in such drops from a C-130.

It has been estimated that *Gemini,* which uses landing skids quite similar to those of the *X-15,* will have about a 200-ft. landing run on a soft field. Forward speed of the landing will be about 45 mph, and studies are being made of using the tipped paraglider as a drag brake upon landing. The landing run on a prepared surface is expected to be about 400 ft.

Present NASA planning rules out the use of Edwards AFB as a landing site because it would require either a higher inclination launch or a shift in orbital inclination after the rendezvous operation. This indicates landing will be in a site further south—perhaps in Texas or at White Sands, N.M.

• **$20 million a shot**—Col. Daniel McKee, Director of Project *Gemini* at NASA's Office of Manned Space Flight, said each *Gemini* launch is expected to cost approximately $20 million, exclusive of development costs. He said *Gemini* would serve very well as a testbed for other space hardware, limited only by the *Titan II* capability.

The present *Gemini* orbit plan, for an 87-mi. perigee and 150-mi. apogee, is mandatory because of this capability, which will not permit a higher orbit, according to McKee. Any higher orbits would require the spacecraft maneuvering system to be used as a "kicker" to circularize the orbit at 150-mi. altitude.



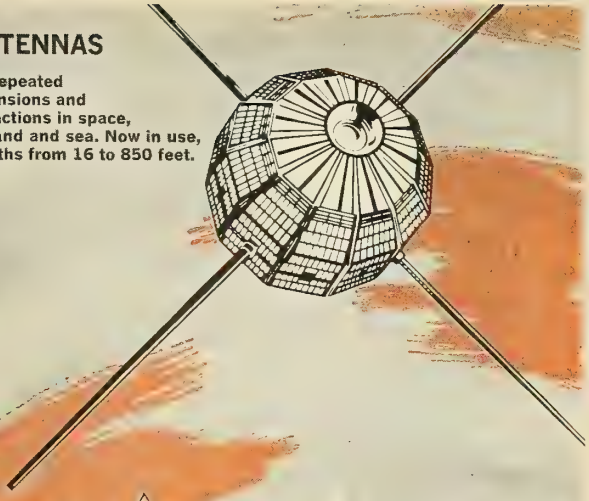
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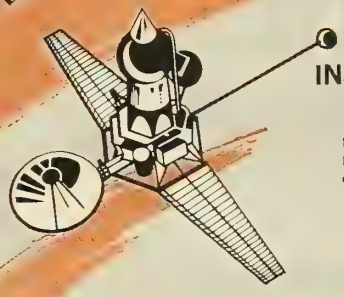
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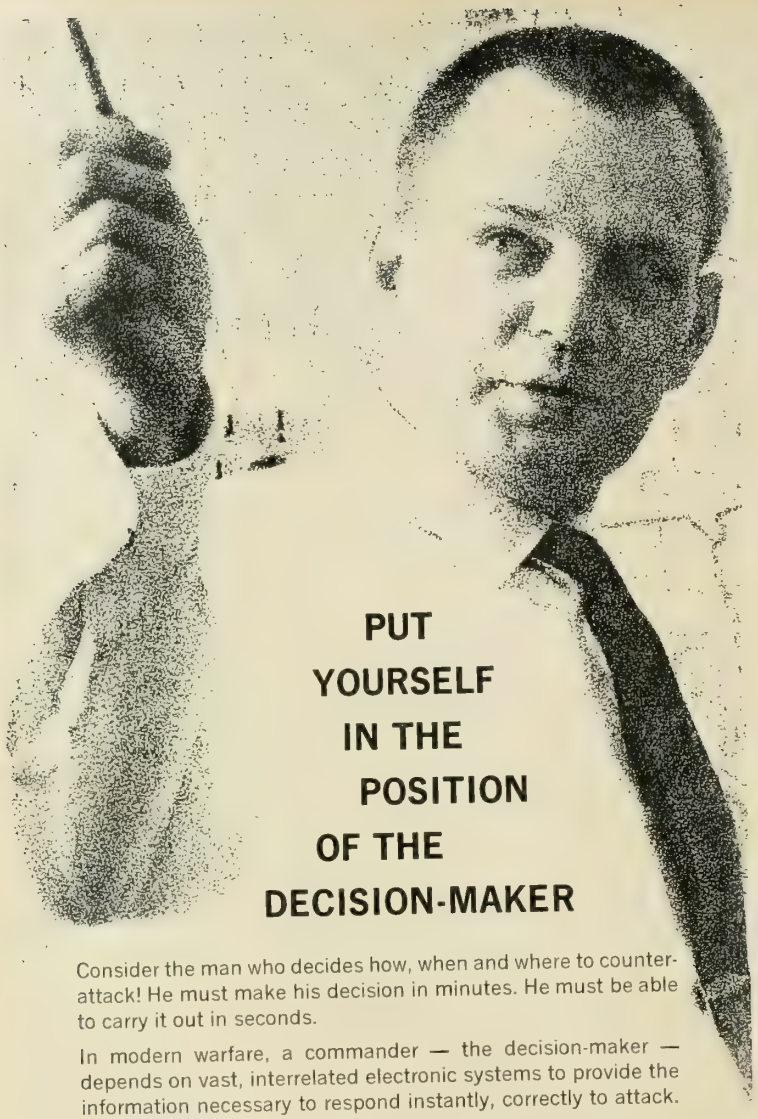
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This would correspondingly reduce the in-orbit maneuvering capability.

Interplay between *Gemini* and *Apollo* programs is largely through MSC at Houston, where each program is staffed by graduates of the *Mercury* project working from common experience and "talking the same language." There are no definite plans to test *Apollo* equipment on *Gemini* capsules, although this will probably come later.

McKee points out that some items of equipment are identical already—such as the 100-lb.-thrust maneuvering rocket engine.

McKee said *Gemini* may have some military applications, but denied that Air Force interest is causing the tight lid on *Gemini* technical information, which has denied press access to internal views and equipment layout plans.

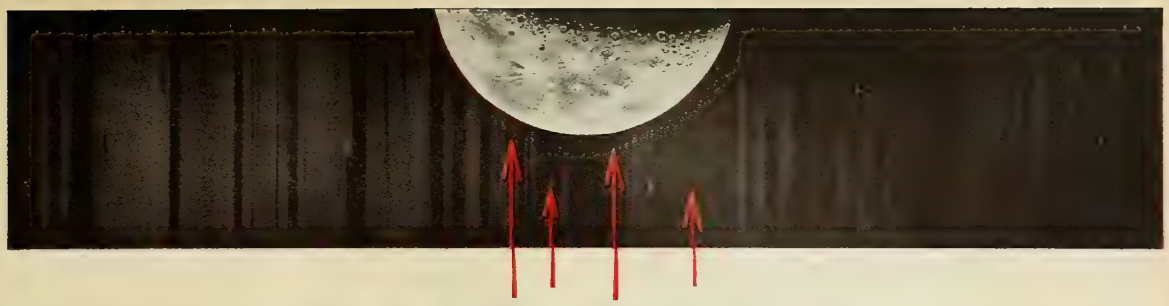
Other sources said any capsules ordered by the Air Force are expected to be a follow-on order to the NASA capsules. NASA is now supplying information and prices to the Air Force and Washington officials of the space agency say they no longer consider a joint program likely. A separate AF space program using the basic *Gemini* capsule modified for AF missions is considered far more likely; as one NASA source put it, "We simply did not design our capsules to meet Air Force objectives."

• **Technical aspects** — A major change in the *Gemini* capsule as compared with *Mercury* (aside from size), is the lift component built into the aerodynamics of the shape. By offsetting the center of gravity, McDonnell Aircraft Co. designers have caused a roll moment to develop which gives the capsule a lift force upon re-entry.

With a 16-degree angle of attack upon re-entry, the *Gemini* can land in a "footprint" pattern along its orbital plane measuring 200 miles across and several hundred miles long. McDonnell points out that this control over landing site allows the astronauts to put the spacecraft down in an area far larger than any error experienced in the *Mercury* program, so that repetition of M. Scott Carpenter's unintentional overshoot is unlikely.

According to NASA comparisons, the *Gemini* re-entry module, without either of the two adapter sections, is 20% larger than *Mercury;* the entire orbiting package, including the two adapter sections, is 100% heavier, although exact weight is still not released. The heat shield on *Gemini* is 20% larger than *Mercury's,* but the internal pressurized volume is 50% greater.

The in-orbit maneuvering capability is achieved with a multiple-chamber Rocketdyne engine using the same propellants as *Titan II* (nitrogen tetroxide and UDMH/hydrazine). The engine



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develops 100-lb. thrust for the alteration of orbital characteristics, and pulses of considerably less than a second are possible. The crew will be able to control the approach to the rendezvous target vehicle within one or two fps, and can reverse the thrust to counteract forward momentum. Nozzles are contained in the retrograde adapter section.

Individual ejection seats will be used, instead of the escape tower, and there will be no automatic escape device. Launch-vehicle parameters will be displayed to the crew to a greater extent than was true in *Mercury*, and the decision to eject will be the crew's.

Solid-propellant gas generators will blast open the two hatches, even at maximum dynamic pressures, and rocket-propelled seats will take the two crewmen 1000 ft. away from the launch vehicle and upward at a 15-degree angle for a 500-ft. altitude gain. The decreased yield of the *Titan II* propellants compared with the cryogenic propellants of *Atlas* allows much greater reaction time for the crew to get out of the *Gemini*. Instead of a near-detonation, the hypergolic propellants of *Titan II* burn rapidly, but not so rapidly as to preclude possibility of ample warning time.

Modular construction of equipment to be used aboard *Gemini* is another major change from *Mercury*, permitting considerably greater versatility of missions. The possible delays in countdown time are far shorter than in *Mercury*, and overall test and checkout time is greatly reduced.

Instead of time-consuming re-working required if a system shows malfunction, the *Gemini* design allows complete removal of the malfunctioning system and replacement. This feature, which covers the entire environmental control system, is what leads the Air Force to hope it can suit the capsule to its needs with minimum modification.

Miniaturization is another field more strongly emphasized in *Gemini* than in *Mercury*. Apparent largely in the modular "black boxes" of replaceable equipment, the miniaturization also permits more space for crewmen within the capsule. The modules are separated into two groups: those directly affecting the life support of the crew, and all other equipment for carrying out the mission. Crew-support equipment will be within the pressure shell, but the other modules will be in the unpressurized area between the capsule's double wall. Inaccessible to crewmen, these modules can be yanked out and replaced on the launch pad from outside the capsule.

McDonnell describes its *Gemini* fabrication unit as a "task force." PERT management techniques are being used in the production setup, just as they were in the latter phases of *Mercury*. ❖

# FRUEHAUF CAPABILITY ADDS TO AMERICAN SPACE AGE MOBILITY

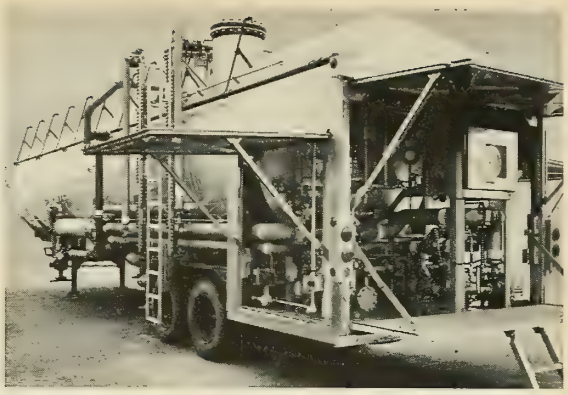
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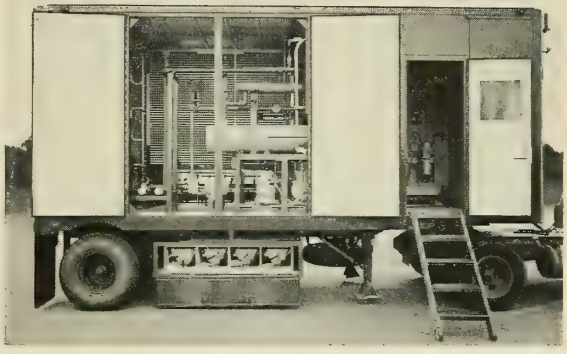
An outstanding example of Fruehauf participation in space age sub-systems, through the liaison of its commercial and military division, is a recent project currently completed for Paul Hardeman, Inc., of Stanton, California, the prime contractor for the U. S. Air Force TITAN II Propellant Transfer System.

To achieve effective mobility, Fruehauf provided the essential equipment for moving the fuel and oxidizer holding tanks, the propellant conditioning system, the control system, as well as the waste disposal equipment. The concept of mobility fulfills the U. S. Air Force's technical requirements for maximum efficiency and illustrates its continuing program of cost reduction and savings to the Government.

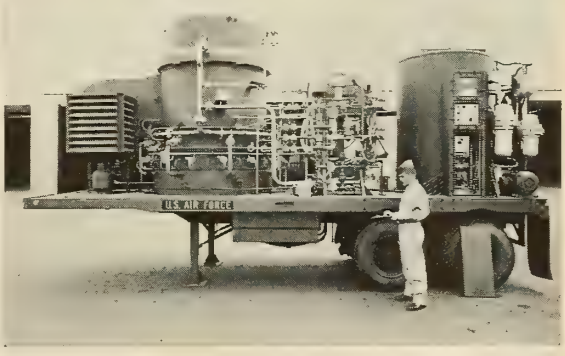
For further information on Fruehauf's demonstrated capability in designing and producing military equipment, send for a free copy of "Fruehauf G.S.E.—Military and Missile".

*"ENGINEERED TRANSPORTATION"*
*—The Key to Transportation Savings*







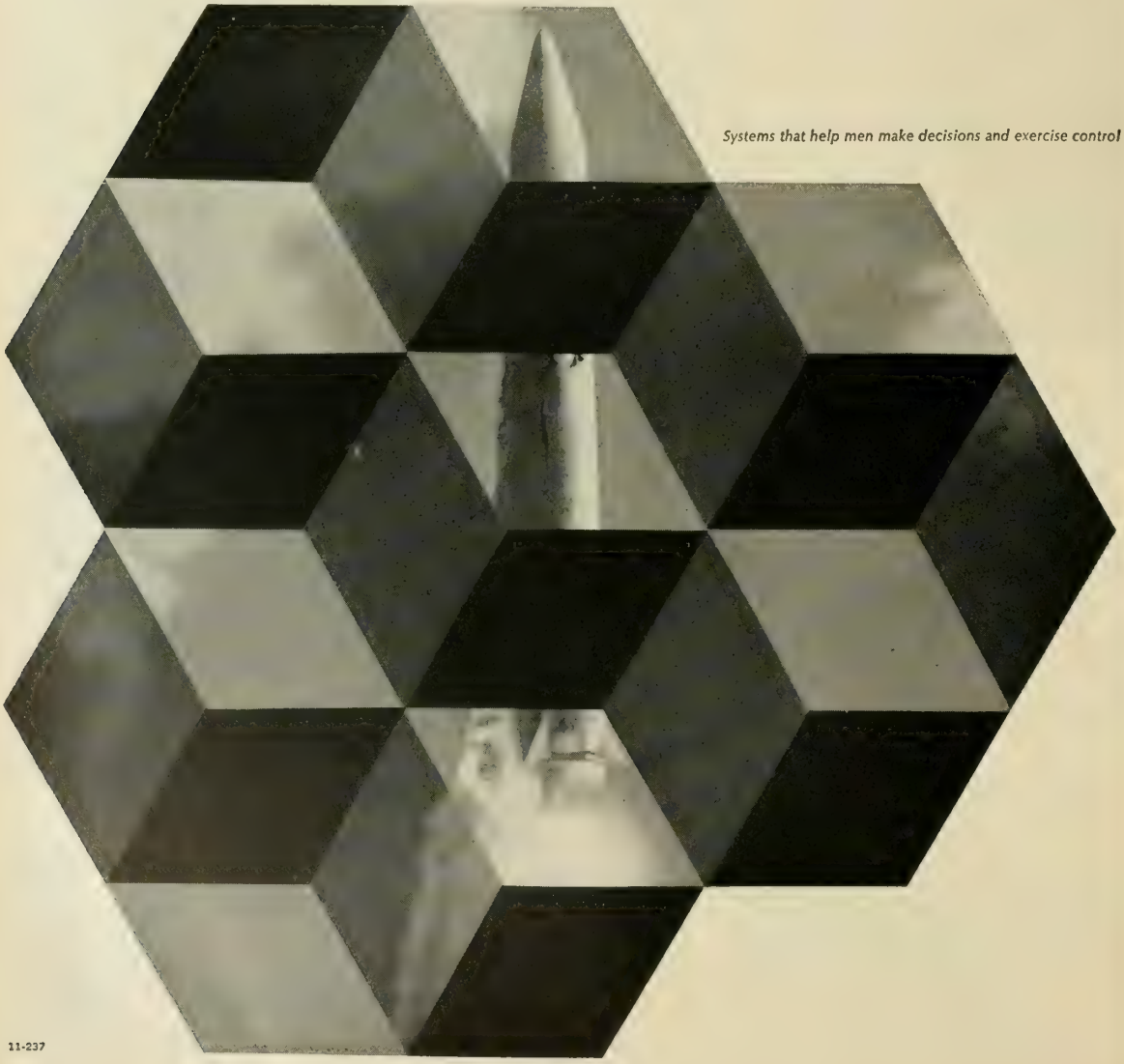




**FRUEHAUF**
**MILITARY PRODUCTS**
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# Decision-Making: Hostile or not Hostile?

*A few years ago this decision was relatively simple. The action that followed was relatively simple. Today the consequences of this type of decision-making can be enormous, affecting world-wide forces and events. The decision itself may trigger an incredibly complex series of interacting decisions and controls. In making these compressed-time decisions, commanders use man-machine systems which provide information processing assistance. The development of these large systems is the work of scientists, engineers and computer programmers at System Development Corporation. The system is their concern, not the actual design of hardware. Specifically, they contribute in these key areas: defining the requirements of the system, synthesizing the system, instructing the computers within the system, training the system, evaluating the system. Throughout they seek to optimize man-computer relationships and to develop a system which grows and changes with the needs of the decision-makers who use it. Human factors scientists, operations research scientists, systems-oriented engineers and computer programmers interested in joining a close interdisciplinary effort are invited to write concerning new positions in this expanding field. Address Dr. H. C. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C., Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."*

**SDC**
**System Development Corporation**

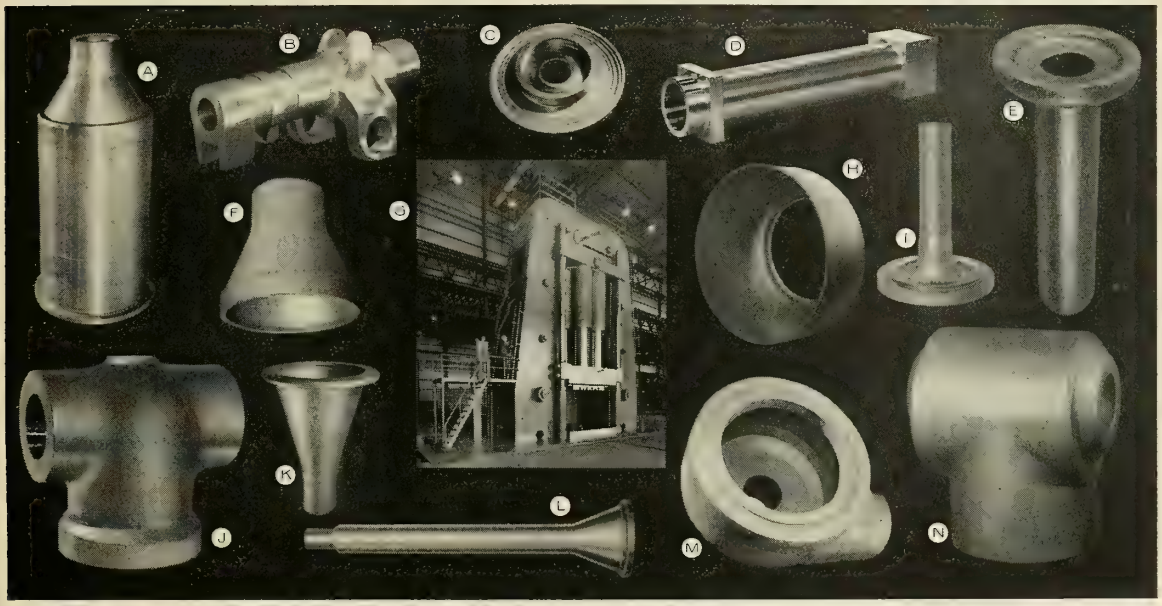


*Systems that help men make decisions and exercise control*

11-237

# FORGING VERSATILITY

Cameron is forging carbon steel, special alloy steel and exotic metals in a wide variety of sizes and shapes. Using the split-die multiple ram process, forgings with complicated shapes, thin walls or multiple cavities are produced in one press operation. Uniform toughness, high impact strength and high tensile strength are acquired. Cameron's 11,000 and 20,000 ton presses are the Free World's largest multiple ram ferrous metal forging presses.




**A. Turbine Shaft**
Material: Waspaloy
Length: 40¾" Weight: 1,000#

**B. Outer Cylinder, Main Gear**
Material: MIL-S-5000B
Length: 60¼" Weight: 2,400#

**C. Turbine Disc**
Material: Incoloy 901
Diam.: 23½" Weight: 190#

**D. Nuclear Reactor Component, Support Tube**
Material: 304 Stainless Steel
Length: 43" Weight: 430#

**E. Experimental Extrusion**
Material: K Monel
Max. Diam.: 16⅛" Length: 29½"
Weight: 195#

**F. Nozzle Liner**
Material: Molybdenum
Max. Diam.: 13⅛" Length: 12"
Weight: 99#

**G. 20,000 Ton Multiple Ram Forging Press**

**H. Aft Closure for Rocket Propellant Case**
Material: AMS-256
Max. Diam.: 54¾" Wall Thickness: ¾"
Weight: 1,225#

**I. P & W Turbine Shaft and Disc**
Material: Incoloy 901
Max. Diam.: 20" Length: 30½"
Weight: 365#

**J. Nuclear Reactor Component, Typical 14" Gate Valve Body**
Material: 304 Stainless Steel
Length: 33" Height: 30"
Weight: 2,785#

**K. Turbine Shaft**
Material: A-286
Max. Diam.: 20½" Length: 32¼"
Weight: 300#

**L. Turbine Shaft**
Material: A-286
Length: 142" Weight: 4,850#

**M. Typical Fluid End— Canned Pump Case**
Material: Ni 72%, Cr 14-17%, Fe 6-10%
Max. Diam.: 47-1/16" Weight: 10,365#

**N. Nuclear Reactor Component, 10" Swing Check Valve Body**
Material: 304 Stainless Steel
Length: 25½" Height: 24¾"
Weight: 1,900#

*Check with Cameron on how Cameron forgings can improve your product.*

Cameron

CAMERON IRON WORKS, INC.
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# there's a ship on the way to the moon

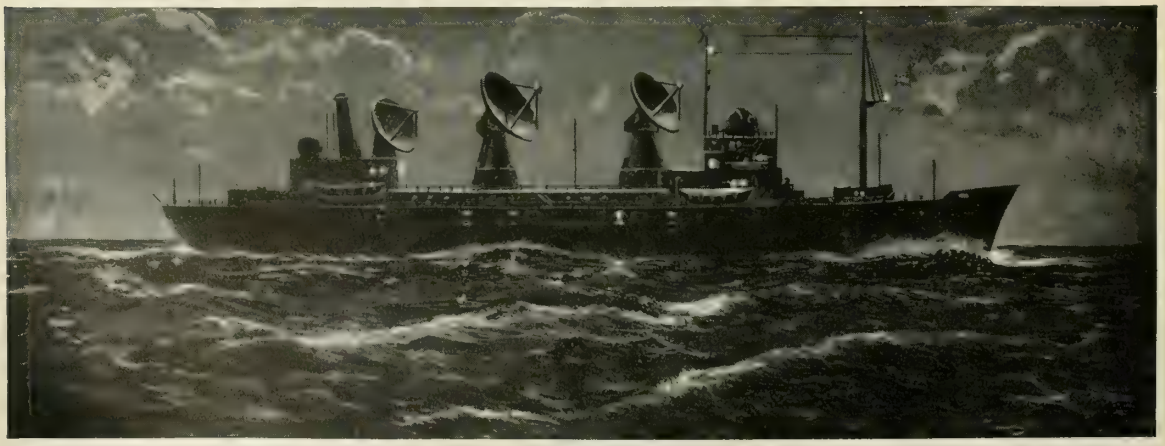
There will be many interim steps, but every shot on the Atlantic Missile Range puts the U.S. closer to its goal of a lunar landing in this decade.

Soon our capabilities on the range will be sharply increased as Advanced Range Instrumentation Ships (ARIS)—large transports converted to seagoing range stations under direction of the Sperry System Management Group—go into service. The highly accurate terminal trajectory and re-entry data the ships collect will greatly advance the system support capability of AMR.

Sponsored by the Air Force Missile Test Center, AFSC, the ARIS ships will incorporate every advanced technique of data acquisition and handling, integrated instrumentation radar, telemetry, inertial navigation, weather forecasting. With mobility and precision they will move to any aim-point in thousands of miles of ocean and take measurements with all the precision of a land-based station. They will provide refined study of space vehicles during the critical terminal phase of flight. Sperry's job is to obtain the finest instrumentation available and integrate it to do the job . . . on schedule and at minimum cost.

The ARIS ships will help fulfill AMR's responsibility with NASA for range instrumentation supporting our exploration of space. The capabilities developed will be steadily advanced in pace with the program. Team members with Sperry include Bethlehem Shipbuilding, Ford Instrument, Gibbs and Cox, IT&T and UNIVAC Division of Sperry Rand.

SPERRY



***ARIS SYSTEM MANAGEMENT GROUP,*** *SPERRY GYROSCOPE CO., DIVISION OF SPERRY RAND CORP., GREAT NECK, N. Y.*



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Allegheny Ludlum

# ALMAR

## MAR-AGING STEELS

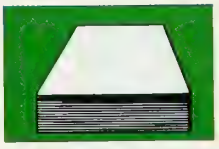
super strength
ductility
with toughness
hardness
simple heat treatment
dimensional stability

Available in ALL FORMS in both production and development quantities from Allegheny Ludlum

# ALMAR steels mean

## Available in ALL FORMS in both production and development quantities from Allegheny Ludlum

### SHEET



Up to 72 inches wide with lengths to suit, just as in stainless steel, is the standard limitation for ALMAR steels. Coiled sheet is available up to 48 inches wide.

### STRIP



All standard stainless steel strip sizes can be duplicated in Mar-Aging steels. At A-L, ALMAR strip down to .010″ thick has been rolled. Should the demand develop, foil will be available.

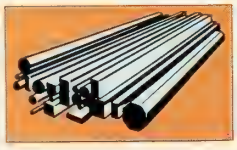


Allegheny Ludlum has furnished much ALMAR plate. Actual production has shown that every plate size made in stainless steel can be duplicated in Mar-Aging steels.

### PLATE

In stainless steel, Allegheny Ludlum furnishes every size and shape of bars. In ALMAR steels, Allegheny Ludlum also can furnish every shape and size.

### BARS



### WIRE

Virtually all stainless steel wire sizes can be duplicated with the ALMAR steels. Actual production has taken place down to .010″ dia., and experimental wire drawing down to .003-4″ dia.





### TUBING

Seamless tubing in the ALMAR steels up to 5 inches in diameter is available from Allegheny Ludlum.



Every shape that can be extruded in stainless steel can be duplicated in ALMAR steels—range up to a shape that can be enclosed in a 5¼″ dia. circumscribing circle.

### EXTRUSIONS

### FORGING BILLETS

ALMAR steels are available in the full range of forging billets, as air melted and consumable electrode vacuum melted steel billets.



# combinations of properties

**Yield Strengths** of 200-280,000 psi with high ductility—55% to 35% reduction of area.

**Tensile Strengths** of 210-290,000 psi with real toughness—Charpy impact up to 16 ft.-lbs., down to 420 F.

**Fracture Toughness** with $G_c$ values over 1,000—at yield strengths up to 280,000 psi.

**Simple Heat Treatment** at low temperature (900 F age) without quench means low cost and no distortion. Welds can be strengthened by local heat treatment.

**Easily Welded—Easily Machined** using the same techniques as for any high strength steel.

Super high strengths with good toughness and easy fabrication make Allegheny Ludlum ALMAR steels really unique.

Developed from an International Nickel Company discovery, A-L's Mar-Aging steels are remarkably resistant to crack propagation and possess unusually low work-hardening tendencies. The Mar-Aging steels first existed as 20 and 25% nickel plus titanium steels. Allegheny Ludlum calls them ALMAR 20 and ALMAR 25 steels.

Now, an 18% nickel steel with cobalt and molybdenum offers the best combination of properties plus simplified heat treatment. This ALMAR 18 steel, through minor composition variations, is produced with strengths from 200-300,000 psi.

Unique among the relatively few producers of Mar-Aging steels, Allegheny Ludlum alone offers ALMAR steels in the *complete range* of mill forms—sheet, strip, plates, bars, wire, tubing, extrusions, and forging billets. They may be obtained from developmental or production size heats, air melted or consumable electrode vacuum remelted. Availability of less than heat lot quantities in any particular product form is, of course, dependent upon inventory of finished or semi-finished stock.

It is this total competence with the Mar-Aging steels that makes A-L's producing role unique . . . *all* product forms and production techniques, including continuous cold rolling, *all* strength levels and *all* compositions, together with Allegheny Ludlum's familiarity with *all* areas of Mar-Aging application presently under investigation. This unique experience with the ALMAR steels is at your service.

**ALMAR**
**MAR-AGING STEELS**

# ALMAR steels are being considered for:



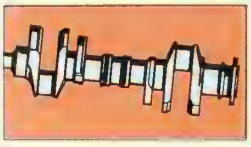
## Rocket Motor Cases.

High strength, toughness and simple 900 F aging heat treatment, without quench, of ALMAR steels explain current evaluation projects for this application. Easy fabricating is a plus factor.

## Highly Stressed Parts.

The inherent super-strength and toughness of the ALMAR steels, results in smaller components to handle high stresses with increased reliability—especially necessary in airframes and airborne equipment.





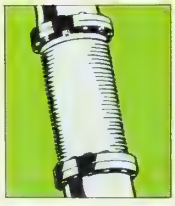
## Large Machinery Parts.

With virtually no limit on depth of hardening of ALMAR steels, strong, tough parts can be made with extremely simple, low cost heat treatment techniques—no quench needed.

## Fasteners.

Tests of bolts in ALMAR 18 steel indicate great utility as high strength, tough components. Also, the cold heading properties are excellent—an unusual characteristic for a super-strength material.



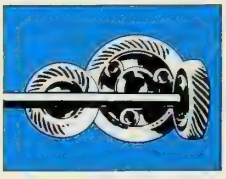


## Sub-Zero Temperature Service.

Strength, toughness of ALMAR steels at cryogenic temperatures are outstanding.

## Wear Contact Parts.

Good results on wear tests plus the inherent high strength, toughness, hardness and simple heat treatment suggest many applications.



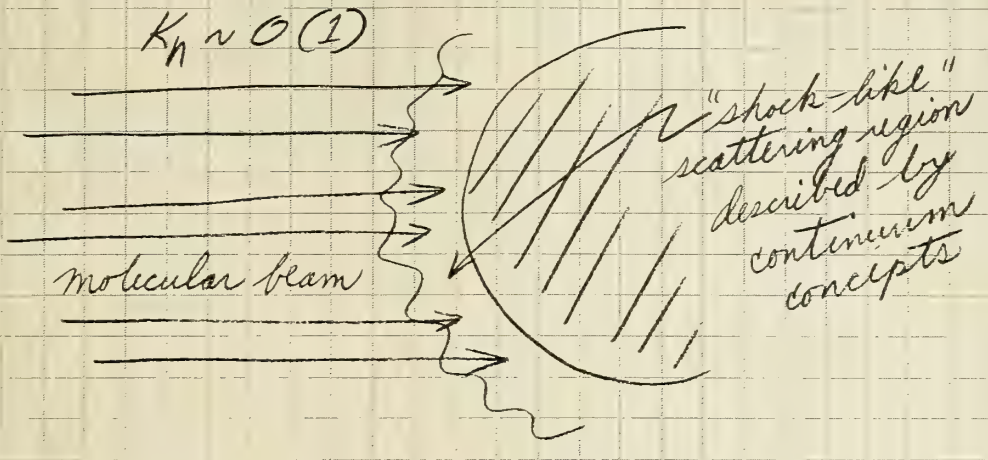
## WANT MORE INFORMATION?

Allegheny Ludlum, the producer with the most experience in making the Mar-Aging Steels in all forms, has available an extensive technical report on the ALMAR steels. A copy of this data-packed booklet is yours for the asking. Check your local A-L District Office, or just write: Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. POM 9.




**ALLEGHENY LUDLUM STEEL CORPORATION**

PIONEERING on the Horizons of Steel




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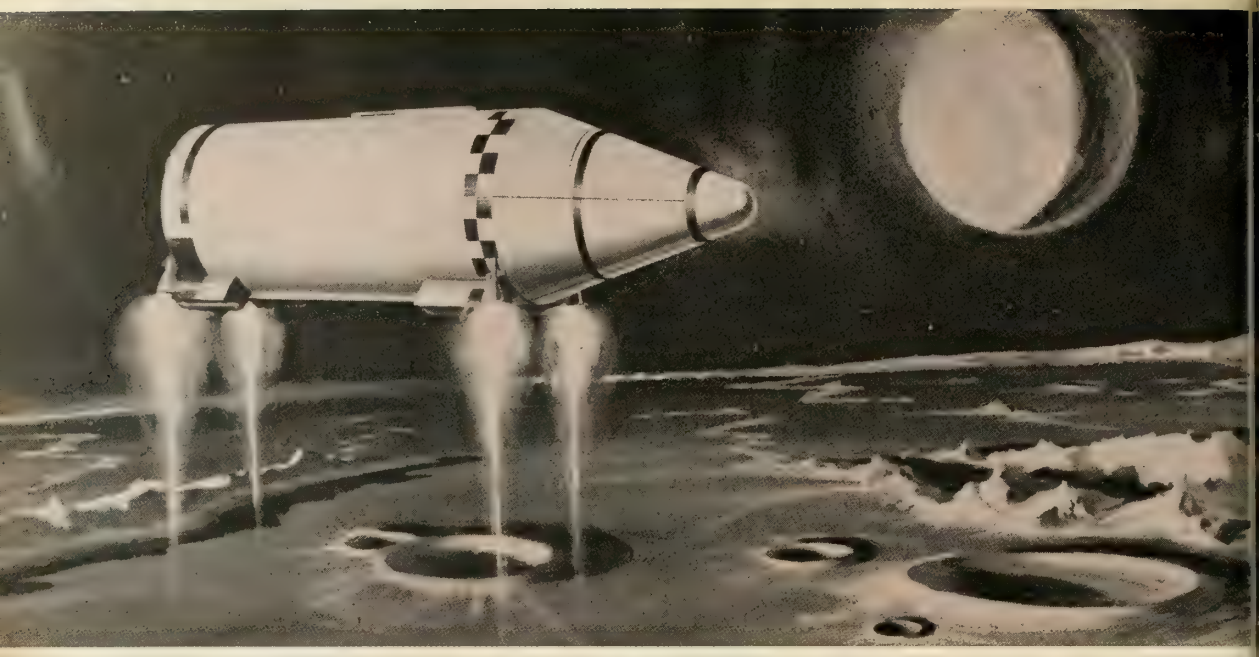
Please send me full information on professional opportunities in my field at Douglas.

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*DOUGLAS CONCEPT of lunar logistics vehicle designed to provide housing.*

## NASA/advanced manned programs

# Future Projects May Cost Billions

***Four-man space station, lunar logistics vehicle have priority in present planning; decisions due imminently***

NASA IS CONSIDERING a multi-billion-dollar advanced manned spaceflight effort including a four-man space station for 1966-67 flights.

The small space station would be the forerunner of a large 20-30-man laboratory which would be flown in 1968-70.

Other major projects include a lunar logistics vehicle (LLV), a lunar base, an aerospace plane and exploration of Mars and Venus.

Although all the projects are in the process of being defined, some decisions on the more immediate ones are expected shortly.

In addition to the space station, the lunar logistics vehicle appears to have the strongest NASA backing. "There's no question but that at some point in time there will have to be a logistics system to expand our lunar activities," a high space agency official told MISSILES AND ROCKETS.

Three LLV study contracts are due at the space agency by Dec. 15. A final decision on the vehicle's specifications is expected to be made by the end of the first quarter of next year. Manned spaceflight officials now hope to initiate procurement near the end of Fiscal '63. Final award of the contract could come early in Fiscal '64.

Current NASA thinking on the other future manned spaceflight programs:

—Lunar base work is further off chiefly because the character of the lunar surface is unknown. Conceptual studies will, however, be performed both by NASA and industrial contractors in the next twelve months. Hardware development would be three to five years away, if a decision is made to go ahead.

—The aerospace plane will be approved, but possibly not for another two years. Earliest procurement and contracting date mentioned is 1965, but a delay of one or two years is possible. Program is almost certain to be a joint Air Force-NASA effort.

—Manned exploration of the near planets would have a total cost of at least $20 billion. For NASA to move ahead in this area would require another national decision similar to President Kennedy's announcement of the U.S. goal to land a man on the Moon by the end of the decade.

NASA officials are doubtful that "scientific necessity" would be sufficiently strong to justify the strong effort needed.

• **Lunar Logistic Vehicle**—NASA is studying LLV to see if it should be an integral part of the *Apollo* program. Such an attachment reportedly is very attractive.

The big question is whether the vehicle should be available to support the first U.S. manned lunar landing or whether its development should be paced to follow-on Project *Apollo* flights.

Officials of the Office of manned spaceflight hold the former view, while other NASA planners are committed to the latter. MSF officials are determined to start procurement of LLV next year. One official told M/R that "we'll scrape

up the money somewhere."

NASA officials feel that LLV "will enhance the safety and performance of lunar landings." These officials hasten to add, however, that "*Apollo* is designed to be self-contained."

The LLV is conceived as carrying equipment directly from Earth to the Moon. Major payloads would comprise a roving vehicle, lunar shelter and equipment for extended stay-times.

Cost of the payload is estimated at $250 million; bus to carry the payload, another $250 million.

Two payload weights are being considered: 25,000 to 30,000 lbs. to ride on the *Advanced Saturn*; or 1500 lbs. to go on the *Saturn C-1B*. The larger payload is favored because fewer launch vehicles and less logistics support would be required. It is also said to be more in line with *Apollo* requirements.

• **Space station**—The manned orbital space station probably will not receive any funds this year other than for continuing study work; the problem is to set up requirements.

Needs for a space station have in the past dictated grandiose designs of "supermarkets in the sky." A first, more modest approach at NASA is that of a four-man station to test out chiefly the physiological effects of prolonged weightlessness or some artificial gravity. "Prolonged" in this case means months rather than days, as in the case of *Gemini*.

A question is raised about what work a space station would be uniquely fitted to do—work that could not just as well be done in appropriately designed laboratories on Earth. The program is therefore being looked at from a cost-effectiveness point of view, to assure NASA of a scientific justification for building the station.

Current thinking is that the four-man station would be a mission module used in either the *Apollo* or *Gemini* spacecraft. A subsequent step would be building a larger space station, holding 20 to 30 men for periods of up to two years.

Contracts for the mission module are expected to be awarded in Fiscal 1965, although some design work may be started late in Fiscal '64. Total expected cost of mission module: $300-$500 million. The date might slip if requirements change.

The next step in space stations—the large erectable version—probably will be operational in 1968-70. To get it in that period, however, hardware development will have to be started in 1966.

• **Lunar basing**—The question of setting up permanent or semi-permanent bases on the Moon has not been thought through yet, because NASA is awaiting some firm data about the lunar surface. *Ranger* is expected to help the space agency decide if a justification exists beyond that for supporting exploring parties on a temporary stay.

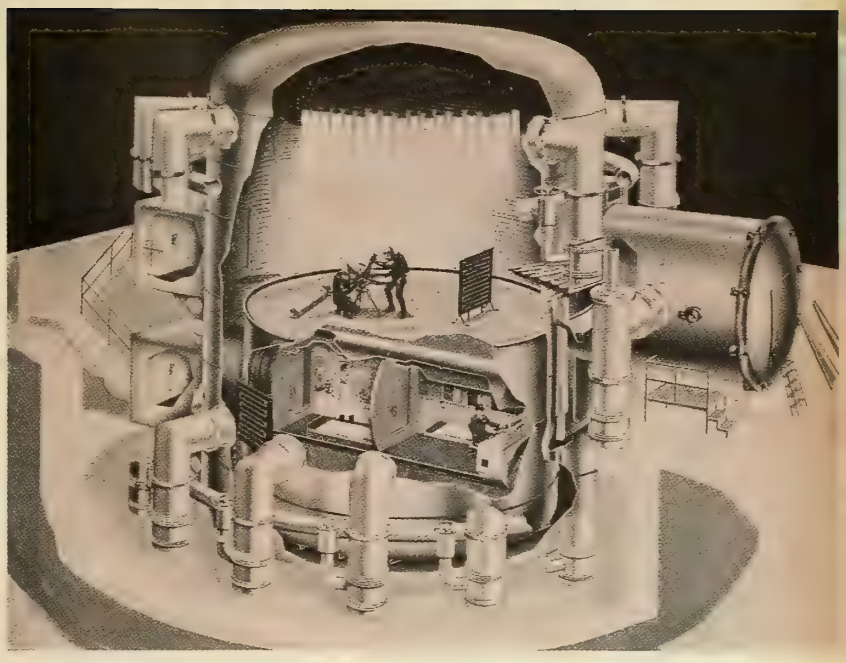
The conceptual studies which NASA plans in the next year will be the beginning of a constantly growing effort to lay out the need, specifications and requirements of a base on the Moon.

• **Post-Apollo projects**—The major space projects after *Apollo* are expected to be lunar basing and manned flight to Mars and Venus.

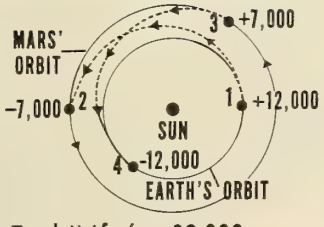
The more difficult of the two ventures will be interplanetary flight. To be successful, it will undoubtedly call for the same national involvement as *Apollo* does now.

The cost is also expected to be about the same as *Apollo*—over $20 billion—and the technical problems of the same relative difficulty.

The time period NASA is thinking about for early manned planetary exploration is 1970 to 1975. This is felt to be a convenient period because the

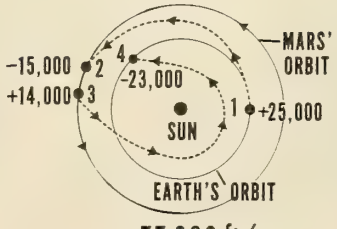


*VERSION OF lunar simulator conceived by Army Corps of Engineers to aid in solution of construction problems expected to be encountered on the Moon.*




Total ΔV ft/sec 38,000

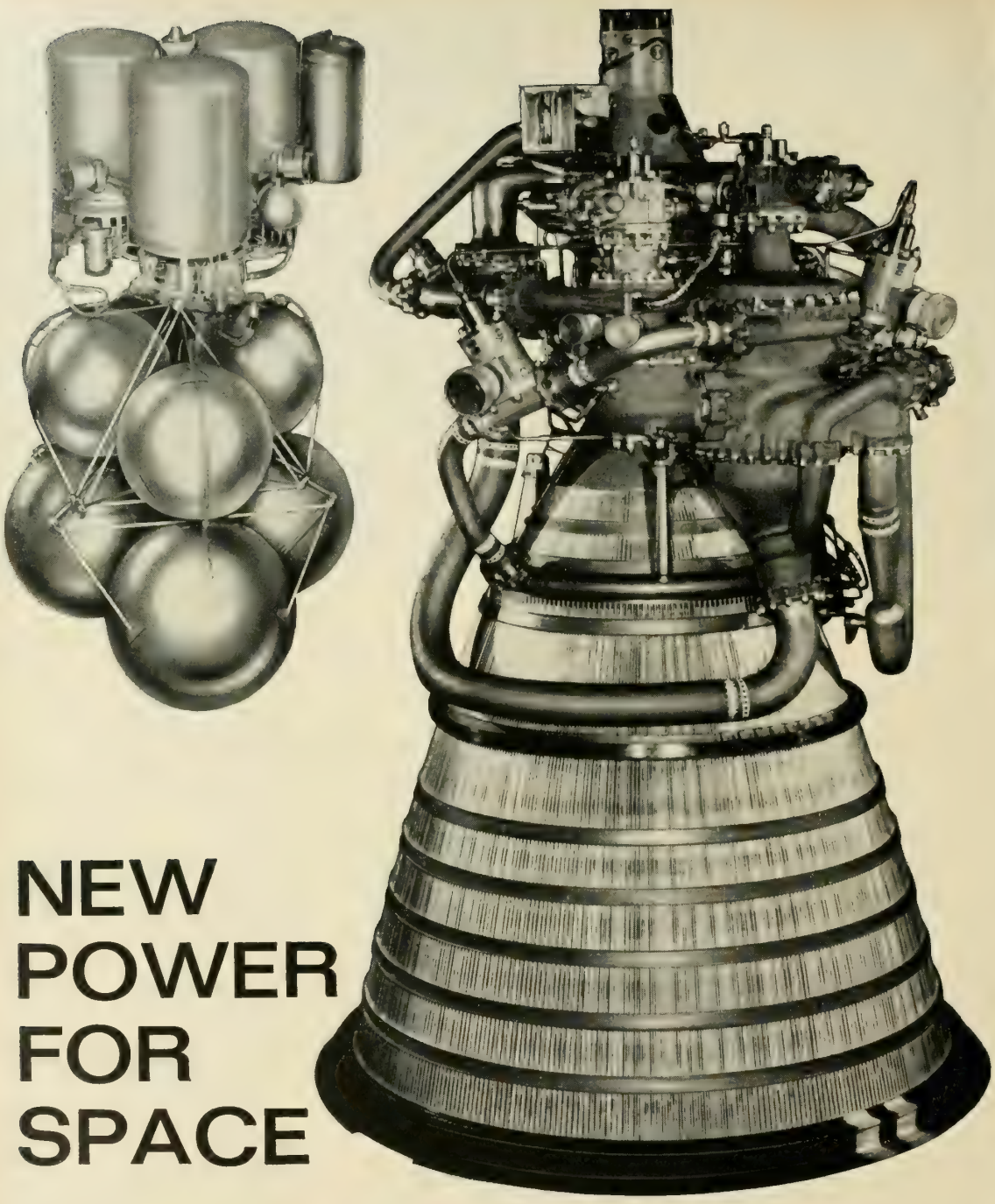
| BETWEEN POINTS: | ELAPSED TIME |
|---|---|
| 1 & 2 | 260 DAYS |
| 2 & 3 | 450 DAYS |
| 3 & 4 | 260 DAYS |
| TOTAL TIME 970 DAYS | |




77,000 ft/sec

| BETWEEN POINTS: | ELAPSED TIME |
|---|---|
| 1 & 2 | 226 DAYS |
| 2 & 3 | 25 DAYS |
| 3 & 4 | 249 DAYS |
| TOTAL TIME 500 DAYS | |

*EXAMPLES OF roundtrip trajectories to Mars.*



# NEW POWER FOR SPACE

These new powerplants are an RL10 liquid-hydrogen rocket engine for propulsion in space, and a model of a fuel cell to provide electricity in manned lunar vehicles. Their mission: Power for space. Their designer and builder: Pratt & Whitney Aircraft for the National Aeronautics and Space Administration.

Pratt & Whitney Aircraft

U

DIVISION OF UNITED AIRCRAFT CORP.

A

EAST HARTFORD, CONN.

peak of *Apollo* spending will be past and the *Apollo* technology hopefully will be well in hand.

Lunar basing would be a concurrent project. But its needs, in terms of launch vehicles, would be less demanding than those of planetary exploration. This last mission, then, would be the one prescribing *Nova* characteristics and beyond.

• **Empire studies**—To get a firmer idea of what manned interplanetary missions to the near planets would involve in terms of launch vehicles, NASA through its Marshall Space Flight Center began in June a set of studies called Empire—Early Manned Planetary-Interplanetary Round-trip Experiment.

Costing $258,000, Empire has each of three companies making six-month studies of selected interplanetary missions: Aeronutronic Div. of Ford Motor Co., $84,000 for a study of fly-by missions to Venus or Mars or both planets (this last mission is familiarly known as "the grand tour"); General Dynamics/Astronautics, $100,000 for studies of the same missions; and Lockheed Missiles and Space Co., $74,000 for studies whose main emphasis is on a Mars stopover mission.

From an astronomical point of view, there are years significantly better than others for launching spacecraft into the vicinity of Mars or Venus. About one favorable opportunity every two years can usually be counted on.

Opportunity for a relatively low-energy grand tour, though, occurs less often: the next chance is in 1970.

• **Planetary fly-bys** — During the fly-by missions, the spacecraft will be able to stay in the vicinity of the target planet for a relatively short length of time—about 10 hours. Even in that length of time, though, astronauts will be able to perform a number of significant experiments: direct exploration of the planet's atmosphere, indirect exploration of the planet's surface by landing experiment-filled unmanned probes, and possibly continuous scientific monitoring of the planet by means of an unmanned satellite left in orbit.

NASA is looking to the universities for help in prescribing the scientific data that should be sought and the means for getting it.

The shortest time for a low-energy fly-by mission is one year. This would be a round-trip to the vicinity of Venus. In fact, Harry O. Ruppe, special assistant to the director of the Future Projects Office, Marshall Space Flight Center, says this flight has just about the lowest requirements for energy of any of the fly-bys—about the amount required by the Hohmann trajectory to the planet.

Studies of this Venus mission gave one unexpected result: the flight could be performed by chemical propulsion alone.

A low-energy fly-by of Mars has also been devised, but it takes a minimum of two years to complete.

These missions are, of course, manned. Crew sizes are expected to be small: three on the lower limit, probably eight on the upper. Ruppe estimates a crew of five might work out to be optimum. One part of the studies now going on is to find what is a reasonable number of crew.

Object of some of the studies now going on is to find out what really is meant when a mission is said to have "low-energy," or can be performed with "relatively little difficulty." What happens when the mission is extended from one year to two years or three years? What does this mean in terms of weights and costs and schedules?

• **Martian module** — The General Dynamics team has investigated a one-and-a-half-year mission to Mars with 30 days' orbit around the planet. The team also looked into the possibility of sending a two-man excursion module to the Martian surface; it would be the planetary counterpart of the lunar excursion module and similarly would be called MEM.

The scout ship MEM would descend from the orbiting mother ship into the Martian atmosphere. It would slow itself first by aerodynamic braking; in final descent, by a parachute plus a chemically fueled retro rocket.

Once on the planet, the men would perform a very simple experiment—probably no more than procuring samples of Martian soil for more leisurely study by others.

A proposed alternate and undoubtedly safer first attempt for a manned landing on Mars is to use two MEM vehicles. The first would be sent unmanned to the planet's surface. If it landed safely, a second and manned MEM would follow. The presence of the first MEM would assure the landing party of at least one adequate return vehicle.

On the other hand, if the first MEM were damaged, the second would be sent down as just another unmanned probe of the planet.

This precaution is essential for a Mars landing because even though an emergency may arise, rescue would be many months to a year away; on the Moon on the other hand, rescue could be effected in less than a week.

• **Flight from Earth**—For both the Venus and Mars missions, the basic assumption is that the interplanetary vehicle would be launched from Earth orbit. This assumes that through the *Gemini* program, the rendezvous techniques had been completely solved. The


SATURN S-IVB...

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**ELECTRONIC SUPPORT**

Utilizing automatic computer controlled checkout systems, the electronic support equipment for the Saturn S-IVB vehicle must provide maximum pre-launch checkout in the shortest possible time. Basic system design concepts, facilities planning, checkout philosophy, and data retrieval and display are currently being formulated.

Douglas is seeking electronic support specialists with experience in total computer design, color TV display, logic design, or other related areas who can meet the Saturn S-IVB challenge in initial design, hardware design and development tests. Send your resume to Mr. W. C. Ames, Saturn S-IVB Recruitment Director, Douglas Missile and Space Systems Division, Dept. J-7, 3000 Ocean Park Boulevard, Santa Monica, California.



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**AC/DC Digital Voltmeter/Ratiometer (Model 551).** New! First to bring you 5 readings-per-second speed with mercury-wetted relays. Full 5-digit, measures DC from 0.0000 to ±999.99 volts to an absolute accuracy within 0.01% of the reading, ±1 digit; AC from 30 to 10,000 cps between 0.0000 and 999.99 volts to an accuracy within 0.1% of the reading or 0.05% of full scale, whichever is greater. Adaptable without modification to fit a variety of data-logging systems. Ideal for laboratory use. Accessories include projection readout, BCD mercury-relay output, 10-line mercury-relay output, and AC converter. Price (without optional visual readout) for the basic 5-digit instrument with buffer register and auto/manual/command range: $4150.

**DC Digital Voltmeter and Ratiometer (Model 507D).** Measures voltages between ±100 microvolts and ±1000 volts, ratios between ±0.0001:1 and ±999.9:1 with 0.01% (of reading) ±1 digit accuracy. Accessories permit AC/DC and AC/AC ratio measurements. Stepping switches guaranteed for 2 years. Price: $3835.

**DC Digital Voltmeter (Model 501B).** Four-digit, fifth-digit over-ranging. Measures positive or negative DC between 100 microvolts and 1000 volts, with 0.01% (of reading) ±1 digit accuracy. Automatic or programmable range; auto polarity. Combines the useful accuracy of a 5-digit voltmeter with the stability, reliability, and price advantage of a 4-digit voltmeter. Stepping switches guaranteed for 2 years. Price: $2995.

**DC Digital Voltmeter (Model 501BZ).** Similar to Model 501B (see above). Circuit is automatically and continually calibrated against a Zener diode reference source instead of against an unsaturated mercury-cadmium standard cell. For submarine and other special environment applications. Price: $3160.

**AC/DC Digital Voltmeter (Model 502B).** Gives you AC accuracy within 0.1% *of reading;* over-ranging on both AC and DC; automatic ranging and remote (programmable) control. Measures DC between ±100 microvolts and ±1000 volts, AC from 30 cps to 10 kc between 1 millivolt and 1000 volts. Five-digit readout. Stepping switches guaranteed for 2 years. Price: $4245.

**AC/DC Digital Voltmeter (Model 502BZ).** Similar to the Model 502B (see above). Circuit is automatically and continually calibrated against a Zener diode reference source instead of against an unsaturated mercury-cadmium standard cell. Price: $4410.

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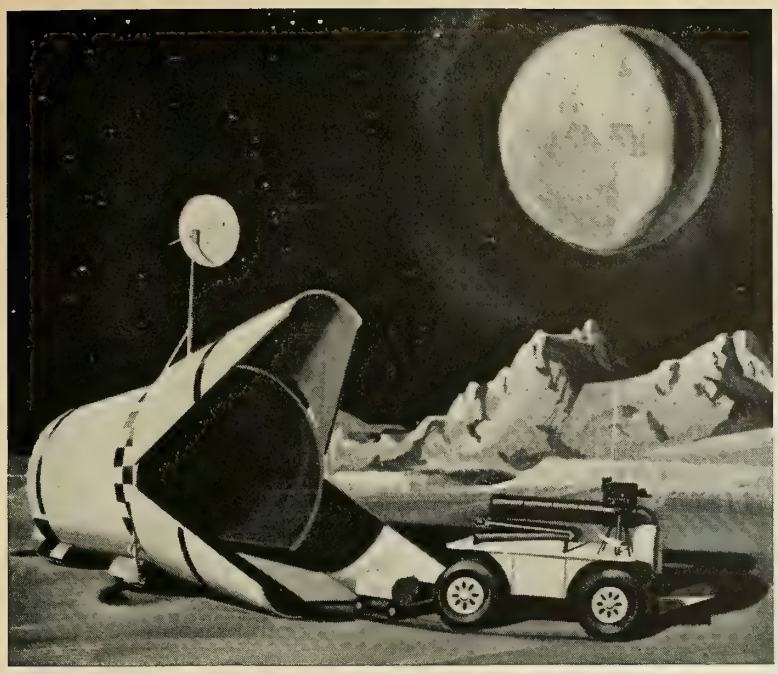



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*ROBOT VEHICLE tows nuclear power source out of lunar shelter. Aft end of shelter is pressurized and would house supplies and equipment.*

interplanetary vehicle would have been taken to Earth orbit by a *Nova*.

Then, by nuclear propulsion—hydrogen the working fluid—the spacecraft would depart from Earth orbit, make a transit to the target planet, and enter the planetary orbit. After its work was done, nuclear propulsion would take the spacecraft out of the planetary orbit and onto the trip back to Earth. Partial nuclear braking would be used to slow the spacecraft to below parabolic speed for Earth capture.

Ruppe estimates that the total weight of the spacecraft starting out in Earth orbit would be between 1 and 2 million pounds—most of it accountable to liquid hydrogen—depending on the mission. The manned capsule would be heavy—of the order of 100,000 lbs.—mostly because of the shielding requirements.

• **Best flight times**—A trajectory analysis made by one of the contractors for the Martian mission indicates two presumably favorable times for the flight: when Mars is at its apocenter—that is, when it is farthest out—and when it is at its pericenter, or nearest.

A curious phenomenon arises, though, because of the fairly eccentric orbit of Mars. When Mars is far out the energy and weight requirements are raised; but when the planet is nearer, it is traveling faster. The relatively slow speed of Mars when it is far out overrides the effect of its greater distance and yields the most appropriate time for Martian intercept.

The most favorable time for Martian intercept is between 1970 and 1972; for some years after 1975 the flight task becomes markedly more difficult. Therefore, if the flights are postponed to the late 1970's, a substantial flight penalty must be accepted.

• **Power required**—The power onboard needed for Empire-type missions is estimated at about 20 to 30 kilowatts—about the output of the prospective *SNAP-8* nuclear unit. The power will be needed for guidance, control and communications; life support system; and possibly for a hydrogen liquefication plant to minimize loss of the fluid through vaporization.

Ruppe pointed out that the estimated cost of upward of $20 billion for missions based on the Empire studies would pay for the planetary fly-bys, manned vehicles, the landing of MEM's, and even for introducing ion propulsion in the late 70's, say 1979.

Ruppe, however, assumes funding only for the procurement of *Nova* vehicles and of nuclear engines—not for their development. Since the *Nova* and nuclear engines are to be used by many programs, it would seemingly be unfair to charge manned interplanetary flight for the R&D work, according to Ruppe.

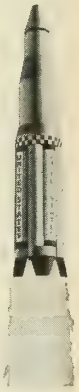
Although the main purpose of the Empire studies is to learn requirements for post-*Apollo* launch vehicles, if these requirements are appropriately met the hypothetical missions will become practicable.

• **Prospects for ASP**—The aero-


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**PROPULSION**

The lunar mission of the S-IVB depends on the use of high performance cryogenic propellants in a main propulsion system capable of engine start at a stage separation and re-start in orbit for the Apollo escape. Attitude control during earth orbit and escape requires a positive expulsion storable propellant system for intermittent operation under zero gravity. Propulsion requirements on S-IVB demand advanced design concepts in automatic checkout, modular pneumatic and propellant components, positive expulsion devices, and zero systems.

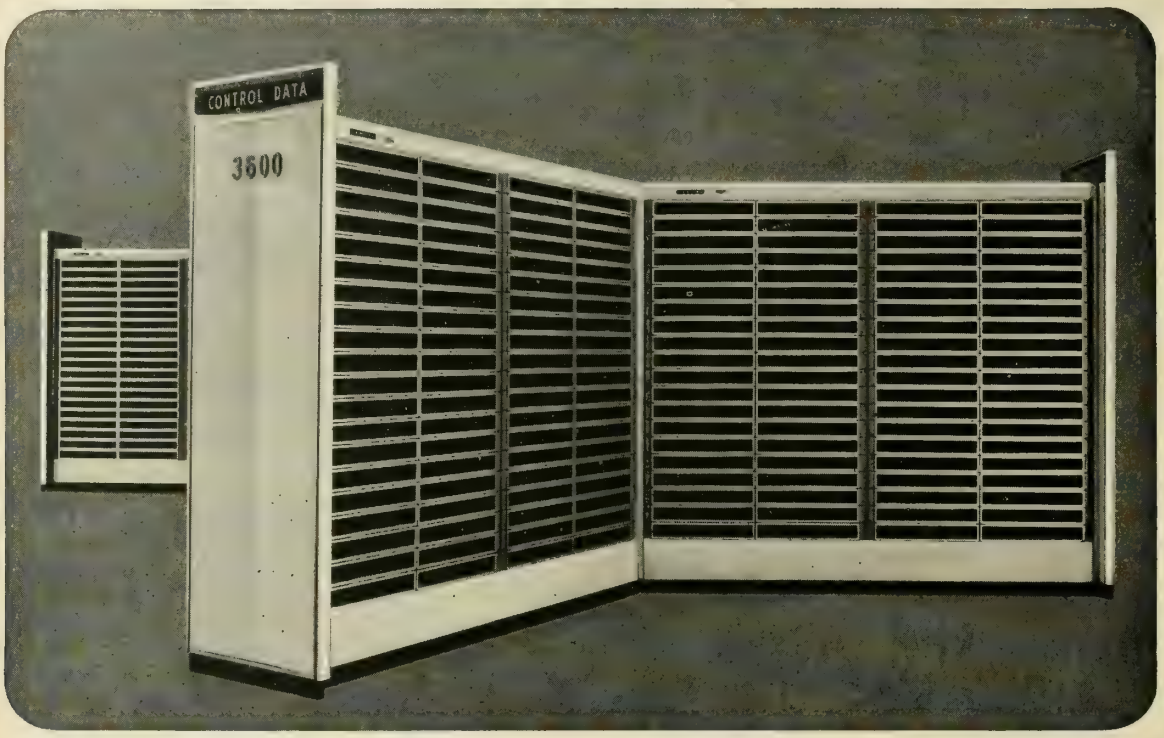
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space plane *(ASP)* is expected to be a billion-dollar project.

Its mission will be to transport men and material economically between Earth and Earth orbit.

Because it will be costly, NASA and the Air Force are planning to fund the project jointly—as they are now doing with the *X-15* rocket airplane.

Development of *ASP*, though not certain, will probably be approved, accordingly to Charles H. Zimmerman, NASA Director of Aeronautical Research. Two years will probably be needed to reach a firm decision—barring a crash program—and another seven to 10 years to design and build the craft.

A two-stage vehicle is foreseen.

• **Background**—The start of a possible NASA-USAF program for *ASP* grew out of a meeting last spring between Brockway McMillan, USAF Assistant Secretary for R&D, and Thomas F. Dixon, NASA Deputy Associate Administrator.

An expanded meeting was set for July where NASA and USAF experts told what might be needed to develop *ASP*. Teams with joint chairmanships were organized to look more deeply into these needs and come back in September with recommendations.

At the September meeting, the teams recommended specific questions to be explored by the two agencies to get a better idea of the scope, manpower and funds needed for *ASP*.

• **Current status**—Tentative plans covering the work that must be done have been proposed and are now being coordinated. The hope is to have another joint discussion in the very near future to get approval of the plans.

A go-ahead, however, will bring new problems to NASA; it will call for more work and funds than the space agency originally expected to spend for initial *ASP* studies. The agency, therefore, will have to decide how much of the work it can afford to do.

• **Cost**—The aerospace plane will probably cost close to $1 billion to develop. "This is a very rough figure," a NASA official explained, "because obviously we haven't gone far enough to quote a solid figure. It could be a large fraction of a billion or even billions."

He drew a parallel between *ASP's* development cost and the *X-15's:* "That *(X-15)* is a relatively simple vehicle and it ran into hundreds of millions of dollars; it's hard to see that the *ASP* could cost less—to say the very least."

• **The ASP mission**—Though civilian and military specifications for an *ASP* system may in some instances differ, the technical aims are the same, according to officials for NASA and USAF. They do not expect possible conflicts in concept to cause any major interagency problems.

"I think the Air Force and NASA agree about the basic mission of the ASP system," Zimmerman said. "We want to get a vehicle system—as economical a one as possible—that will be a means of transportation and logistics support for Earth-orbiting space stations." He emphasized, "it is essential that we recover the components instead of throwing them away; therefore we are working toward recoverable stages."

Zimmerman stressed "economical": "If you're going to have space stations we want to be able to service them without bankrupting the country everytime you send men and material up there."

The present concept is of a vehicle that will take off and land like an airplane. "What we might be forced into is something else," said Zimmerman. At the present, though, the picture is of "flying machines complete in themselves rather than having parts that drop off and are recovered by parachutes or other means."

*ASP* will have no function in space other than to get there. NASA, therefore, considers it an aeronautical vehicle system rather than a space vehicle system. For this reason, technical responsibility for its development once the project is approved will be under Charles Zimmerman.

• **ASP design**—Chances are that *ASP* will be a two-stage device: the first stage would boost the vehicle to speed and then would be piloted back to Earth; the second stage, meanwhile, would proceed to rendezvous with its men and materiel.

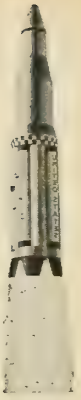
The Air Force would much prefer doing the job in a one-stage vehicle, but it does not seem possible within the present stage of technology.

• **Timetable**—"Our hope is to decide within the next couple of years if we should go ahead with *ASP*, and in what direction," said Zimmerman. "Then come the design studies."

The two years will be spent with in-house studies and possibly some by industry to help us reach decision," Zimmerman explained. He pointed out that the *X-15* took five to seven years from the time of the first serious studies of the system until the first vehicle was flying. *ASP* is not expected to take a shorter time.

Zimmerman estimated a seven-to-ten-year period after initial studies before there would be a flying *ASP*. Nearer ten years seemed more likely, according to Zimmerman, but "it could be shortened under a crash program."

At the present time NASA is budgeting its *ASP* work under its hypersonic research vehicle program: there is no line item in the NASA budget for an aerospace plane. ⌗

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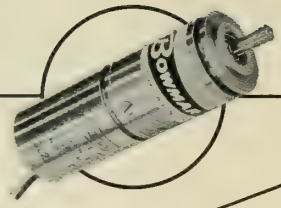
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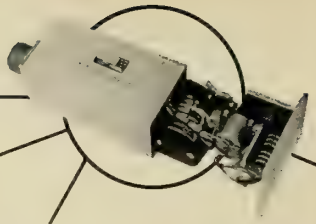
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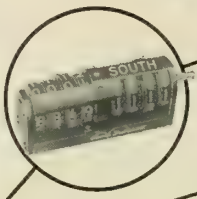
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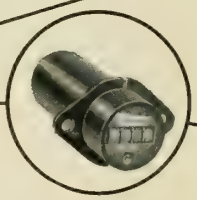
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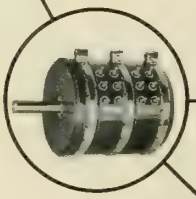



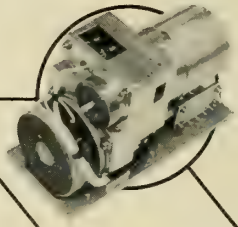


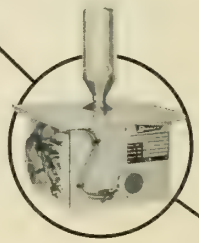










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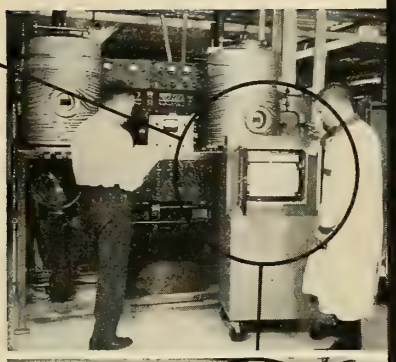
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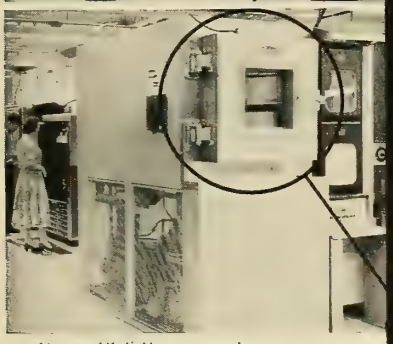
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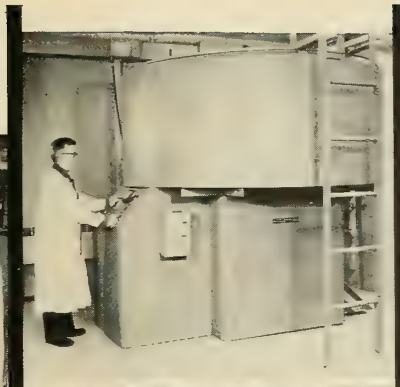


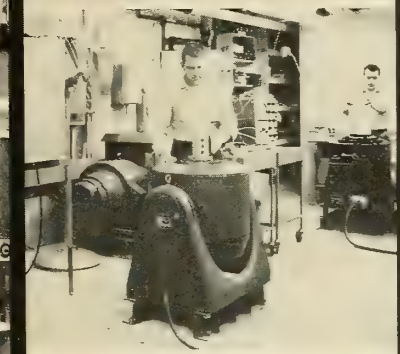
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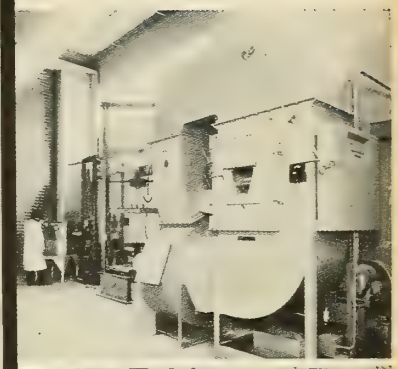


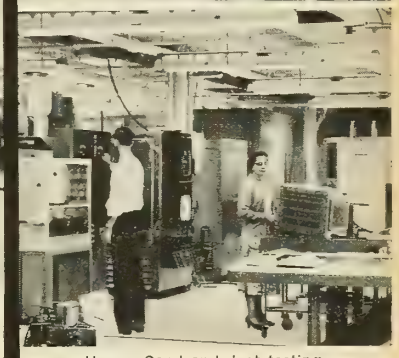
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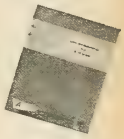
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# Post-Saturn Booster Picture Cloudy

***Overall vehicle program may have $2-billion pricetag in FY '64; Nova due in '65-'66—or when there's money***

AS NASA MOVES into high gear in the manned lunar program, large launch vehicles beyond the *Advanced Saturn* are practically slipping out of sight.

Official estimates now put *Nova* vehicle development in the late 1965-1966 calendar period—and even these projections are qualified. In spite of this, NASA experts are confident about the eventual existence of a *Nova*. The problem is funding.

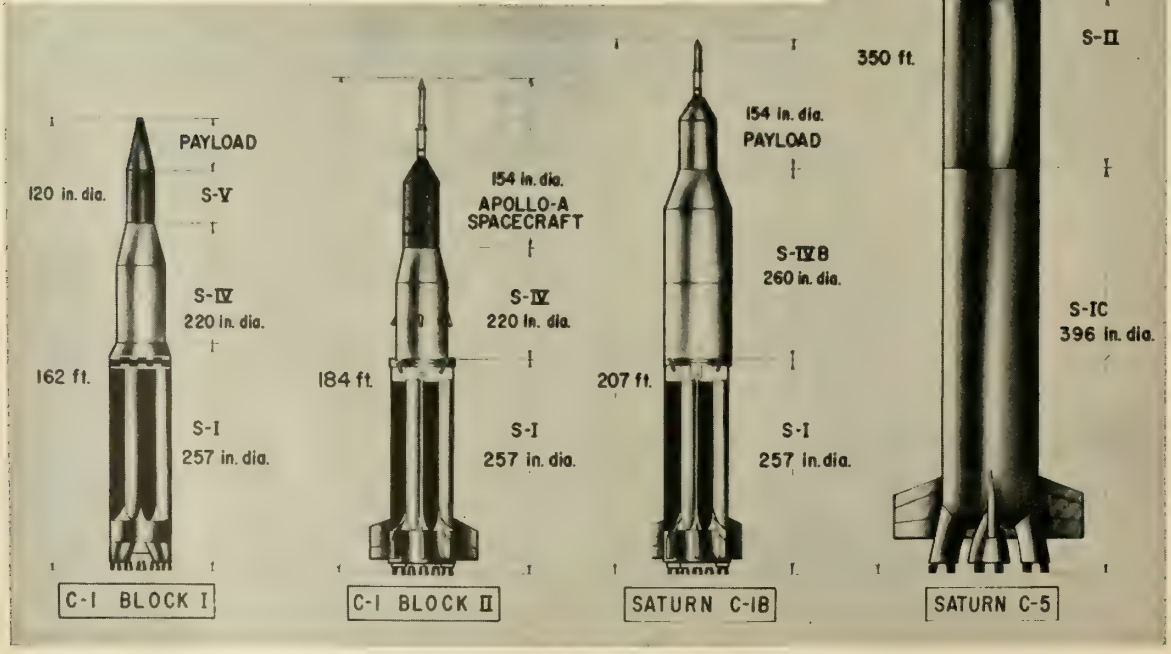
The overall launch vehicle program may account for about $2 billion of the Fiscal 1964 NASA budget—with the lion's share going to support the *Apollo* program. Facility and test-stand construction will absorb around $500 million of this total.

The vehicles involved are the *Saturn* family—the *C-1*, *C-1B* and *C-5*—with total launch vehicle costs pegged at approximately 50% of all expenditures needed to put an American on the Moon.

A more detailed breakdown has $200 million slated for vehicle development in the *C-1* program in fiscal '63, expected to drop to about $60 million in FY '64. *Apollo C-1* and the related *Little Joe* vehicle procurement will take about $50 million in fiscal '63 with the bulk going to the *Saturn*. Fiscal '64 spending here will amount to about $100 million, almost all for the *C-1*.

In addition, space sciences and lunar probe programs will require two or three *C-1* vehicles in Fiscal '64.

Funding for the *Advanced Saturn* will hit the $300-$350 million mark in




**Drawings Show Planned Growth in Saturn Family**

Fiscal '63 with a programed rise to around $700 million expected in FY '64. *Scout, Atlas-Agena, Delta* and *Thor-Agena* vehicle-procurement costs through program completion are listed with the NASA Scientific Satellite Section in this issue (see p. 109).

The *Centaur* program was recently shifted from Marshall Space Flight Center to the Lewis Research Center, and a detailed program review is in progress. *Centaur* funding totalled $100 million in Fiscal '63 and is expected to remain the same for the next fiscal year. The *Gemini* launch vehicle *(Titan II)* expenditure will amount to about $25 million in FY '63.

• **Nebulous Nova**—Study efforts on post-*Saturn* boosters have been in progress for some time by the Future Projects Office at Marshall Space Flight Center, both in-house and funded to industry.

Certain *Nova* studies in the works might easily form the preliminary design for a firm hardware program if the decision to go came by next summer. But these are study efforts, and FPO spokesmen are careful to emphasize the "study" aspect.

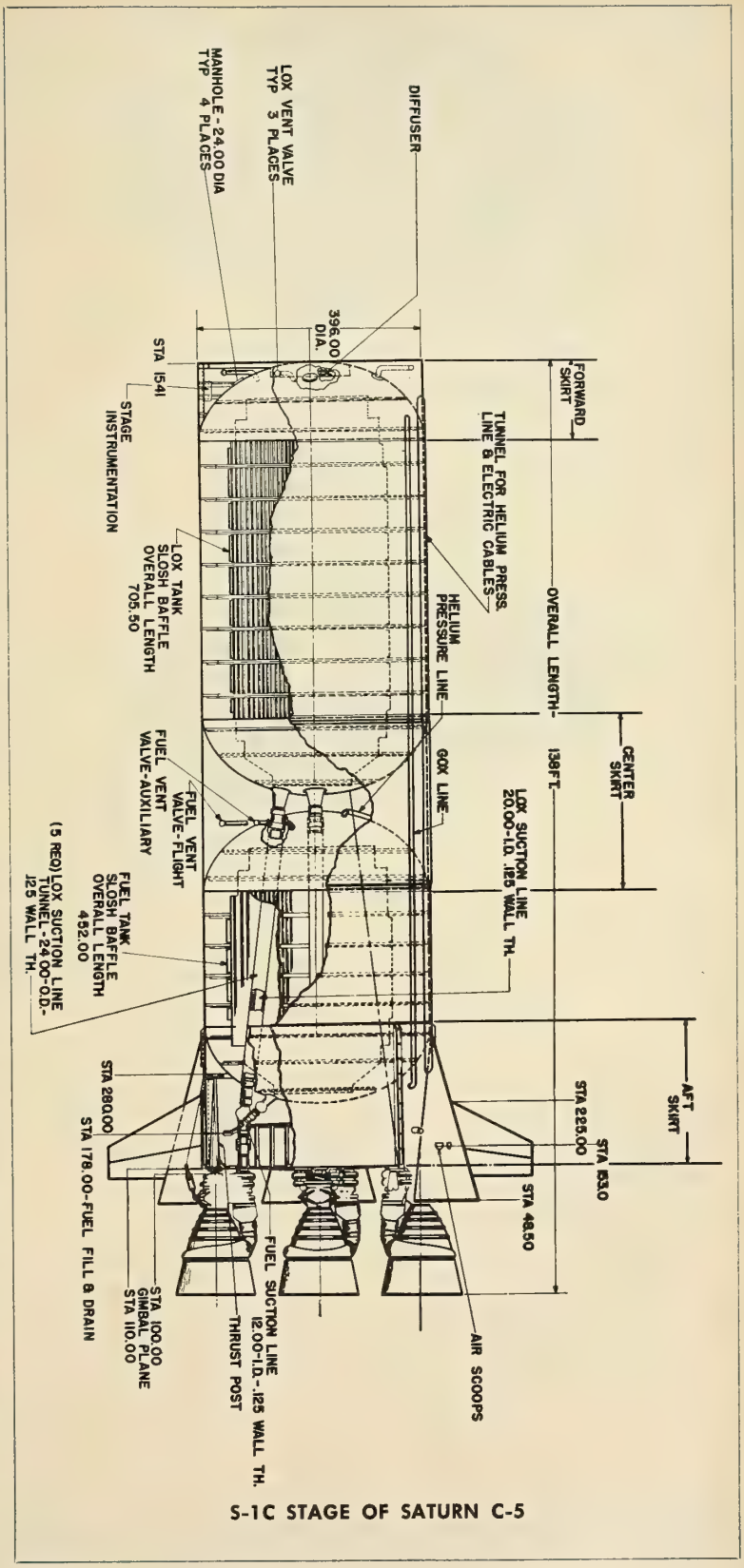
Study programs, however, provide NASA with the depth needed to move actively into a hardware program. This, in the case of *Nova,* includes all the operations necessary to support a system — ground facilities, fabrication, transportation, launch complex, etc.

In all their work, FPO experts face the problem of obsolescence, especially when hardware decisions are delayed, as is often the case. But this does not render a study useless. In fact the groundwork, with changes and implementation, usually is applicable to another, more advanced, concept.

The *Nova* vehicle makeup is not yet known although studies in progress at Martin and General Dynamics/ Astronautics should clarify the concept. The vehicle is to have two to three times the weight-lifting capability of the *Saturn C-5:* to launch 45 tons to escape velocity or to place 120 tons in Earth orbit.

Part of Future Projects thinking includes the assumption that NASA may not want the currently defined *Nova,* and study inputs are being correlated to define something referred to as the "next large launch vehicle after the *C-5.*" This might be a *Nova* type or what is called a post-*Nova* vehicle.

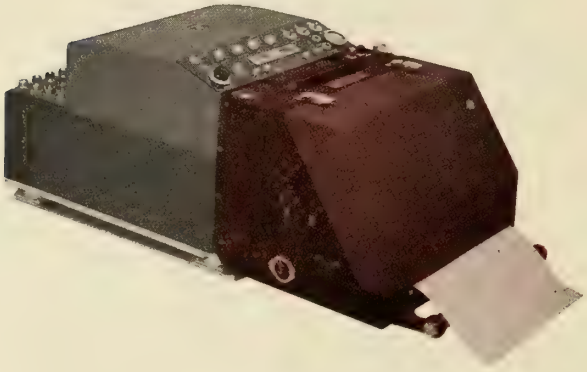
• **FPO functions**—All programs in the FPO deal with launch vehicles; payloads are considered lumps of poundage. Studies now in progress are not limited to *Nova,* or even a liquid *Nova.* Boeing is under contract to investigate the possibility of a solid-fueled *Nova*-type booster.




S-1C STAGE OF SATURN C-5



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Other studies involve a solid *C-1*-type *Saturn* and a second-generation, more-sophisticated, liquid *C-1* with the same basic capabilities as the current model.

There are investigations into upgrading the basic F-1 engine or F-1 derivatives to a single unit thrust of about 2.5 million lbs. A list of pending study contracts illustrates the scope and depth of the possible launch vehicles under consideration.

These include the post-*Nova* vehicle, a re-usable 10-ton orbital carrier vehicle, a re-usable ground-launch vehicle in the 50 to 100-ton orbital payload class, the *Nova* solid-propellant vehicle preliminary design, an advanced lunar transportation system, a planetary trajectory manual, an early manned planetary mission *(EMPIRE)*, a low-acceleration space transportation system, application of solids to future *Saturn C-1*-class vehicles, Earth orbital operations manual and lunar flight handbook, and the *Nova* vehicle system.

Most of these studies range in the $50,000 to $400,000 class except the *Nova* vehicle project. This carries a planned price tag of $2.1 million. But Future Projects gets much more than the allotted dollar figures indicate. In many cases, contracted firms invest their own funds in the studies.

Almost all studies farmed out to industry are on an open-bid basis, but to win acceptance a firm must prove capability in the study area. NASA will always choose the firm that stretches the study dollar furthest. For instance, all other things equal, one company may have already embarked on a computer program within a study contract area. NASA would grant the study to this firm since one aspect of the job is already done.

• **Industry help welcomed**—Future Projects welcomes industry help. Deputy Director Frank L. Williams says one of the most fruitful areas within the interrelated studies is the recognition of problems only industry can handle—welding thick aluminum on a production basis, for example.

The severe budget limitations impose another qualification on future large launch vehicles—the concept of re-usability. Recoverability means the difference between limited attacks on space and a full-scale series of operations—covering lunar bases, manned satellites and planetary exploration.

Some NASA experts are fully convinced the *C-5* is the last reasonable expendable booster the economy can provide without seriously impairing programs other than manned lunar landing and establishment of men on the Moon.

Recovery systems have been under

study for several years and the prevalent opinion is that such systems can be produced without technical breakthroughs or any stretch in the state of the art. Some industry spokesmen call it a matter of engineering development.

There are certain general problem areas inherent in booster recovery no matter what size the vehicle. Expendable launch vehicles are designed primarily to achieve structural-weight-to-propellant-weight ratio, maximizing the payload.

This design criterion means the vehicle will have deceleration loads and re-entry heating conditions complicating the design of the recovery technique. After separation, a recovery system must provide for proper vehicle stabilization and orientation, means to reduce vehicle velocity to alleviate re-entry loads and aerodynamic heating, and terminal descent and landing.

In each case, it must be determined if the vehicle's natural stability characteristics will suffice or if it will require kick rockets, stabilization fins, inflatable drag devices or other means to obtain proper attitude alignment during re-entry

• **Separation questions**—If the unstable vehicle develops tumbling or flat spin rotational motion at separation, or both, these must be eliminated during free flight. These motions could easily break the vehicle into fragments.

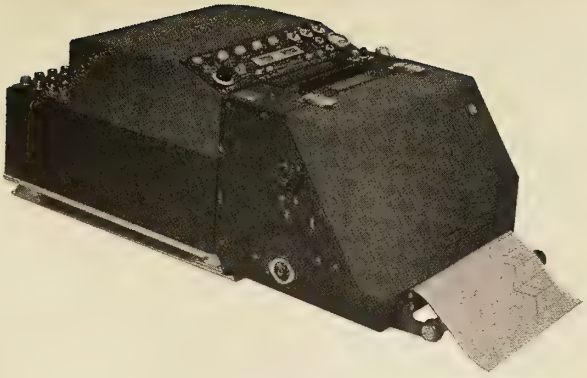
In addition to natural aerodynamic instability, separation might impart an initial motion to the launch vehicle—through the use of separation retros or second-stage ignition into the top of the first stage.

This initial motion may start residual propellants sloshing inside the tanks. This leads to another consideration—dumping of residuals. While dumping appears feasible, trade-off studies may indicate that addition of propellant-dumping capabilities is a detriment to mission reliability.

Investigations show present designs offer little hope of surviving re-entry deceleration loads. Controlling the energy of the vehicle during this phase will be necessary. Since deceleration—as well as heating rates—depends greatly on vehicle configuration and trajectory, both of these must be carefully considered, say NASA experts, before selecting the recovery-system method.

In terminal descent and landing, the recovery system is a function of allowable vehicle structure loads. Marshall experts have investigated water landings somewhat extensively, and the penalty in terms of corrosion and refurbishment costs does not seem to be as high as previously anticipated.

The immediate benefits of recovery include post-flight examinations, re-use

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of flight-proven hardware, cost reduction, and avoidance of expended booster fallout. By far the most important in terms of *Nova* and post-*Nova* vehicles is the cost-reduction aspect.

A considerable effort is being made to adapt recovery systems to the *Saturn* family, all the way from the *C-1* to the *C-5*. But all these vehicles are expendable, as currently defined.

• **Current Saturn status**—The *Saturn* series starts with the *C-1*, Block I and runs through the massive *C-5* or *Advanced Saturn* in an orderly, funded schedule—aimed primarily at completing the manned lunar landing task but having the capability of innumerable other missions.

The *C-1*, Block I version of *Saturn* consists of a maximum of three stages—*S-1*, *S-IV*, and *S-V (Centaur)* in a 10-vehicle research and development program. Two of the tests using the *S-1* and inert upper stages were successfully completed with launchings down the Atlantic Missile Range Oct. 27, 1961 and last April 25.

The first four flight tests will have inert upper and live first stages only, with the live second stage *S-IV* moving into the test program in the fifth and sixth test flights. The 10-flight schedule is directed primarily at proving the vehicle itself, with a secondary mission of testing early *Apollo* models.

The *C-1* series has been modified to handle two of the three *Apollo* modules through an increase in the propellant capacity of the booster from 750,000 lbs. to 850,000 lbs. beginning with the fifth flight, and the addition of two engines to the *S-IV* stage. The extra engines push *S-IV* thrust from 70,000 to 90,000 lbs.

The *Saturn C-1* booster, or *S-1*, generates 1.5 million lbs. thrust from eight Rocketdyne *H-1* engines—each ultimately contributing 188,000 lbs. thrust. The *H-1* engine is an advanced offspring of the *Jupiter* and *Thor* engine using RP-1 and LOX as propellants.

An eight-leg thrust frame supports the *H-1* engine cluster, with four inboard engines rigidly fixed at an angle of 3° to the longitudinal axis of the booster. The four outboard engines are gimballed and placed at a 6° angle to the axis.

Nine separate tanks—one center and four outer LOX vessels and four outer fuel tanks—feed the engines, with interconnection provisions made to bypass a failed engine and feed all the propellant to the remaining seven if an in-flight malfunction occurs.

• **Work sites**—The *S-1* is under development at the Marshall Space Flight Center with initial boosters being assembled at the facility. Twenty-one "operational" boosters will be built by Chrysler at the huge Michoud complex near New Orleans.

The *S-IV* second stage of the *C-1* series is being built by Douglas Aircraft and consists of 6 *RL-10* Pratt & Whitney 15,000-lb.-thrust engines. The propellant combination is liquid hydrogen and LOX housed in a single self-supporting tankage complex with a common bulkhead separating the two.

The *S-IV* vehicle is controlled by gimballing the six engines in response to signals from the vehicle instrument unit located just forward of the stage. Each engine is mounted at a 6° angle out from the centerline.

This basic vehicle has an Earth orbit capability of about 20,000 lbs. and will be used to perform early flight tests of prototype *Apollo* spacecraft modules as well as to supplying launch-vehicle program data.

This represents the *C-1* Block II booster combination, including the increased propellant capacity and the addition of aerodynamic fins.

A third stage, the *S-V* or *Centaur*, will be used for certain *C-1* flights requiring escape velocity, such as soft-landing instruments.

The *C-1* Block II launch vehicle is not powerful enough to lift the complete lunar exploration spacecraft into Earth orbit. The *Lunar Excursion Module* puts the *Apollo* package beyond the *C-1*. NASA filled this gap by creating a *Saturn* hybrid—the *C-1B*, a mixture of *C-5* upper stages and *C-1* boosters.

The *C-1B* will be able to place about 32,000 lbs. in Earth orbit It consists of the *C-1* booster and the *C-5* third stage, liquid hydrogen *S-IVB*. The latter is under development by Douglas Aircraft.

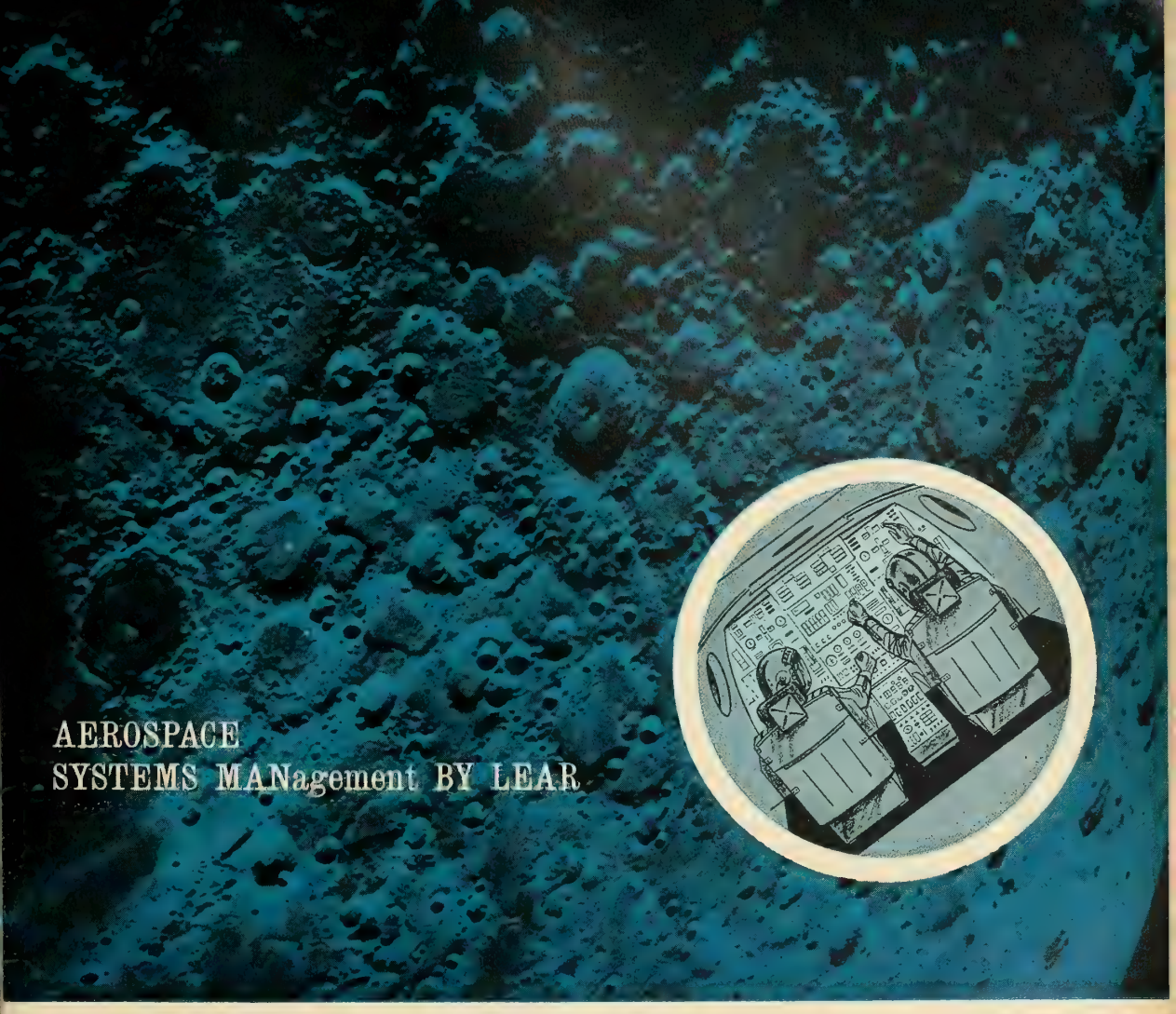
The *S-IVB* uses a single J-2 engine, providing about 200,000 lbs. thrust with tankage sized for approximately 230,000 lbs. of propellant for orbital operations—including allowance for boil-off and power during orbital coast.

This stage will draw heavily on the technology developed in the *S-IV* program. The *C-1B* concept makes possible complete flight testing of the *Apollo* module complex a year earlier than originally planned. It also checks out flight characteristics of the *S-IVB* a year sooner than expected.

• **Advanced configuration**—The last configuration in the current *Saturn* family is the massive *Advanced Saturn* or *C-5*—destined to support circum-

| LAUNCH VEHICLE | STAGES | THRUST (1000 LB.) | PROPELLANT | DIAMETER | HEIGHT | PAYLOAD (1000 LBS.) 300 NM | PAYLOAD (1000 LBS.) ESCAPE |
|---|---|---|---|---|---|---|---|
| SCOUT | 1. Algol | 98 | Solid | | | | |
| | 2. Castor | 48 | Solid | 3.3 ft. | 65 ft. | 0.15 | |
| | 3. Antares | 13.6 | Solid | | | | |
| | 4. Altair | 2.8 | Solid | | | | |
| DELTA | 1. Thor (DM-18) | 150 | LOX/RP | | | | |
| | 2. AJ10-118 | 7.7 | WIFNA/UDMH | 8 ft. | 90 ft. | 0.5 | 0.06 |
| | 3. Altair | 2.8 | Solid | | | | |
| THOR-AGENA B | 1. Thor (DM-21) | 165 | LOX/RP | 8 ft. | 76 ft. | 1.6 | |
| | 2. Agena B | 16 | IRFNA/UDMH | | | | |
| ATLAS-AGENA B | 1. Atlas D | 367 | LOX/RP | | | | |
| | 2. Atlas D (sustainer) | 80 | LOX/RP | 10 ft. | 91 ft. | 5 | 0.75 |
| | 3. Agena B | 16 | IRFNA/UDMH | | | | |
| CENTAUR | 1. Atlas D | 367 | LOX/RP | | | | |
| | 2. Atlas D (sustainer) | 80 | LOX/RP | 10 ft. | 100 ft. | 8.5 | 2.3 |
| | 3. Centaur | 30 | LOX/RP | | | | |
| SATURN C-1 | 1. S-1 (Eight H-1) | 1500 | LOX/RP | | | | |
| | 2. S-IV (Six A-3) | 90 | LOX/LH | 21.6 ft. | 125 ft. | 20 (15 without restart capability) | |
| ADVANCED SATURN | 1. SI-C (Five F-1) | 7500 | LOX/RP | | | | |
| | 2. S-II (Five J-2) | 1000 | LOX/LH | 33 ft. | 270 ft. | 200 | 80 |
| | 3. S-IVB (One J-2) | 200 | LOX/LH | | | | |
| ATLAS D | | 367 | LOX/RP | 10 ft. | 72 ft. | | |
| ATLAS II | 1. XLR-87 | 430 | Storable | 10 ft. | 90 ft. | | |
| | 2. XLR-91 | 100 | Storable | | | | |

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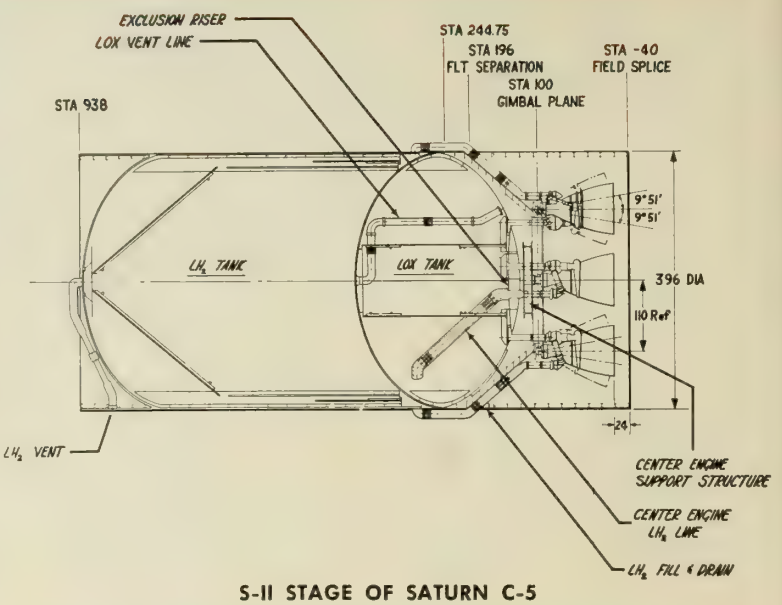
lunar flight and the manned lunar landing. The *C-5* development requires only a modest extension of present technology, but the extreme size and weight of the vehicle and its stages pose new problems in fabrication, handling, test and transportation.

The *C-5* first stage, or *S-1C*, is under development by Marshall and the Boeing Co. A final, definite contract with the Seattle firm is expected before the end of this year. It will run through 1966 at an anticipated cost of more than $300 million.

Basic configuration of the *S-1C* is cylindrical, with separate propellant tanks. Suction lines from the forward LOX tank will pass through funnels in the fuel tank to the engines. Dry weight of the stage will be around 280,000 lbs., with a propellant capacity of about 4,400,000 lbs.

The stage's structural configuration will be an all-welded assembly of cylindrical ring segments with dome-shaped bulkheads. Both tanks will have slosh baffles over the full depth of the liquids.

Five Rocketdyne F-1 engines will form the propulsion package, giving a total rated thrust of 7.5 million lbs. The F-1 is now being static fired. Production engines will be delivered to NASA in 1963.




**S-II STAGE OF SATURN C-5**

Four of the engines will be mounted on a 364-in. diameter ring with the pumps inward. One engine is rigidly mounted on stage centerline. The four outer units will be gimballed and shrouded for protection against external aerodynamic loadings.

The LOX system will be pressurized by gaseous oxygen generated through engine-coupled heat exchangers. The kerosene fuel system will be pressurized by liquid helium stored in pressure bottles.

Design of the stage is a joint undertaking between Boeing and Marshall. Boeing will produce 24 flight units at the Michoud plant. The flight units will be static fired at the Mississippi Test Facility but earlier non-flight versions will be tested at Marshall.

The second stage of the *C-5*, the *S-II*, under development by the Space and Information Systems Div., North American Aviation, will generate one million pounds of thrust with five J-2 LOX/liquid hydrogen engines. The J-2 engine is being developed by the Rocketdyne Div., North American.

The *S-II* will be controlled by gimballing the four outer engines, placed in a square pattern. The fifth engine will be rigidly mounted in the center. The primary guidance and control signal will be provided from the vehicle instrumentation unit located forward of the last stage.

NASA plans currently call for the furnishing of the *S-II* complete with interstage to the *S-1C*. Since the separation scheme is a short coast before engine ignition, retro rockets will be required on the first stage and ullage rockets will be provided on the *S-II* to assure proper propellant seating before ignition.

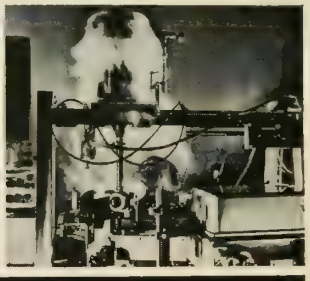
The third stage of the *C-5* is the *S-IVB* described earlier in the *Saturn C-1B* configuration.


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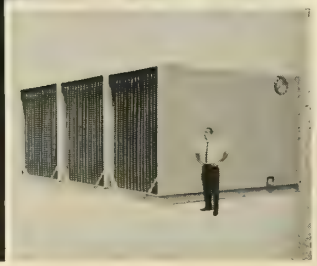
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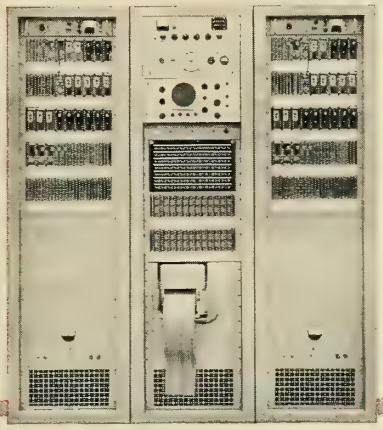
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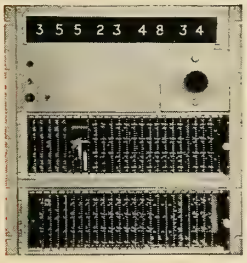
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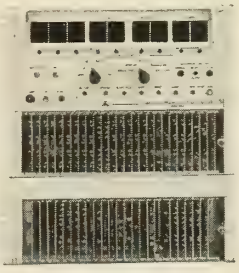

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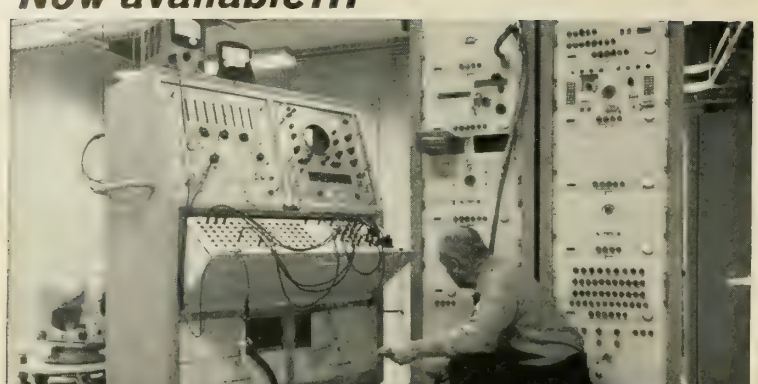
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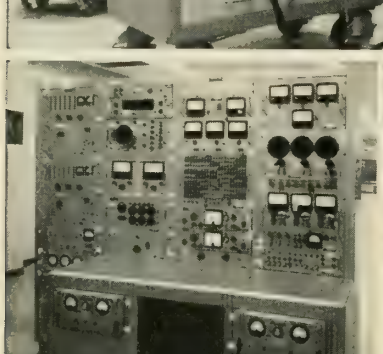
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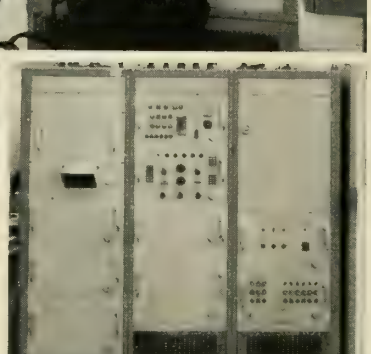
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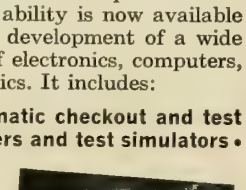


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• **Marshall procurement**—The Procurement Office at the Marshall Space Flight Center handles all contractual purchasing related to the center's mission, which is developing and operating NASA launch vehicles. The office, under Wilbur S. Davis, is being reorganized to reflect its responsibility with respect to the Michoud Assembly Plant and the Mississippi Test Facility.

The two new facilities are part of the Marshall complex. They are under its administrative direction and responsibility, though most of the work performed at both places is under contract to various organizations.

Most NASA business in support of Michoud and MTF will flow to subcontractors directly from the prime industrial contractors operating at the installations. *Saturn* booster vehicles will be manufactured at Michoud by the Chrysler Corp. and Boeing, and tests of these will be conducted at MTF.

Companies interested in being placed on Chrysler's bidding list should contact Henry Sinclair, Manager of Purchasing, Chrysler Space Div., Michoud Operations, P.O. Box 26018, New Orleans 26, La.

Those interested in Boeing should contact John R. Barnard, Materiel Manager, The Boeing Co., Aerospace Div., SATURN Booster Branch, P.O. Box 26088, New Orleans 26, La.

The Marshall Procurement Office currently is being reorganized and, as this issue went to press, only the office breakdown in terms of functions was available. Individuals had not yet been assigned to fill all the slots created, but the functional breakdown is presented here as a guide.

Firms with product, services or components in the launch vehicle area should contact both NASA and the prime contractors involved, says Davis.

The Marshall procurement breakdown and functions includes:

—Office of the Chief—Plan and administer a complete range of purchasing and contracting operations, which encompasses proposal, negotiation, award and administration of contracts, and procurement of services and supplies.

—Policies and Procedures Staff—Initiates and administers policies and procedures. Recommends adjustments, changes and improvements to overall procurement operations.

—Assistant for Systems—Performs duties as assistant for all systems procurement to Chief, Procurement and Contracts Office.

—Stages Branch—Negotiates and administers all methods and types of contracts necessary to provide research, design, development, fabrication, and other services relative to space vehicle

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stages, excluding Michoud Operations.

—Propulsion Branch — Negotiates and administers all methods and types of contracts necessary to provide research, design, development, fabrication, and other services relative to space vehicle engines.

—*RIFT-Agena* Branch—Negotiates and administers all methods and types of contracts necessary to provide research, design, development, fabrication, and other services relative to *RIFT* and *Agena.*

—Michoud Branch — Negotiation and administration of all methods and types of contracts necessary to provide complete development, engineering, fabrication, and support services required for operation of Michoud Facility.

—Assistant for Mission Support—Performs duties as Assistant for Mission Support to Chief, Procurement and Contracts Office.

—Program Support Branch—Negotiation and administration of all methods and types of contracts necessary to provide research and other services relative to program support.

—Vehicle Components Branch—Negotiation and administration of all methods and types of contracts necessary to provide research and other services relative to vehicle components.

—Plant Support Branch—Negotiation and administration of all methods and types of contracts necessary to provide research and other services necessary for plant support.

—Construction & A.E. Branch—Negotiation, formally advertise and administer all methods and types of contracts relative to construction and architectural-engineering service.

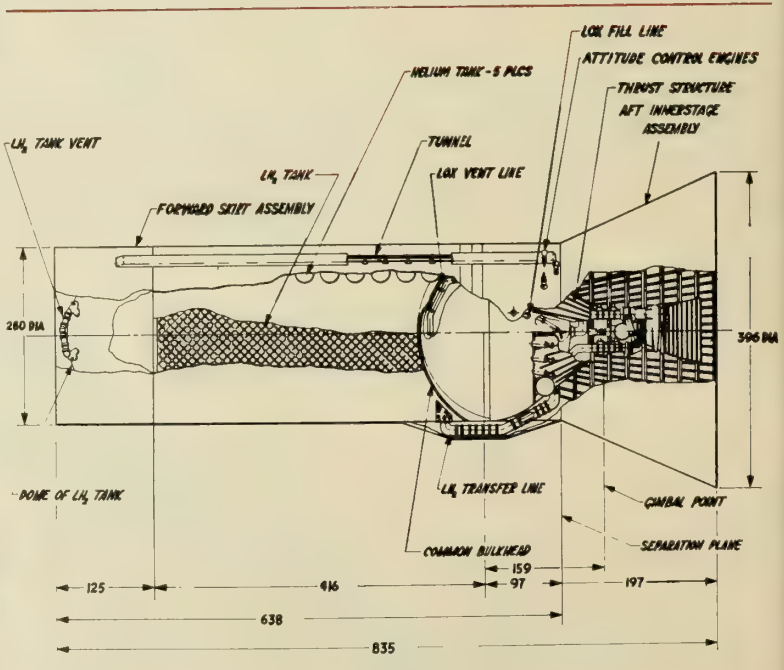
—Assistant for Operations — Performs as assistant for operations to Chief Procurement and Contracts Office.

—Administrative Office — Performs procurement review of purchase requests and contract awards, and maintains bid office. Determines projected manpower and makes defense material system ratings. Provides all administrative services and administers security and procurement sources program.

—Procurement Assistant Liaison Office—Performs liaison with all segments of the Center; coordinates procurement services, and provides advice and assistance on procurement matters.

—Price Analysis Office—Conducts cost analysis of proposals; analyzes financial statements; assists in pre-award surveys; and advises and submits recommendations on all contract pricing and financial matters.

—Industrial Property Office—Protects the government interest in industrial property matters; arranges for necessary equipment, surveys accountable procedures and directs storage, maintenance and repair of government-furnished property.




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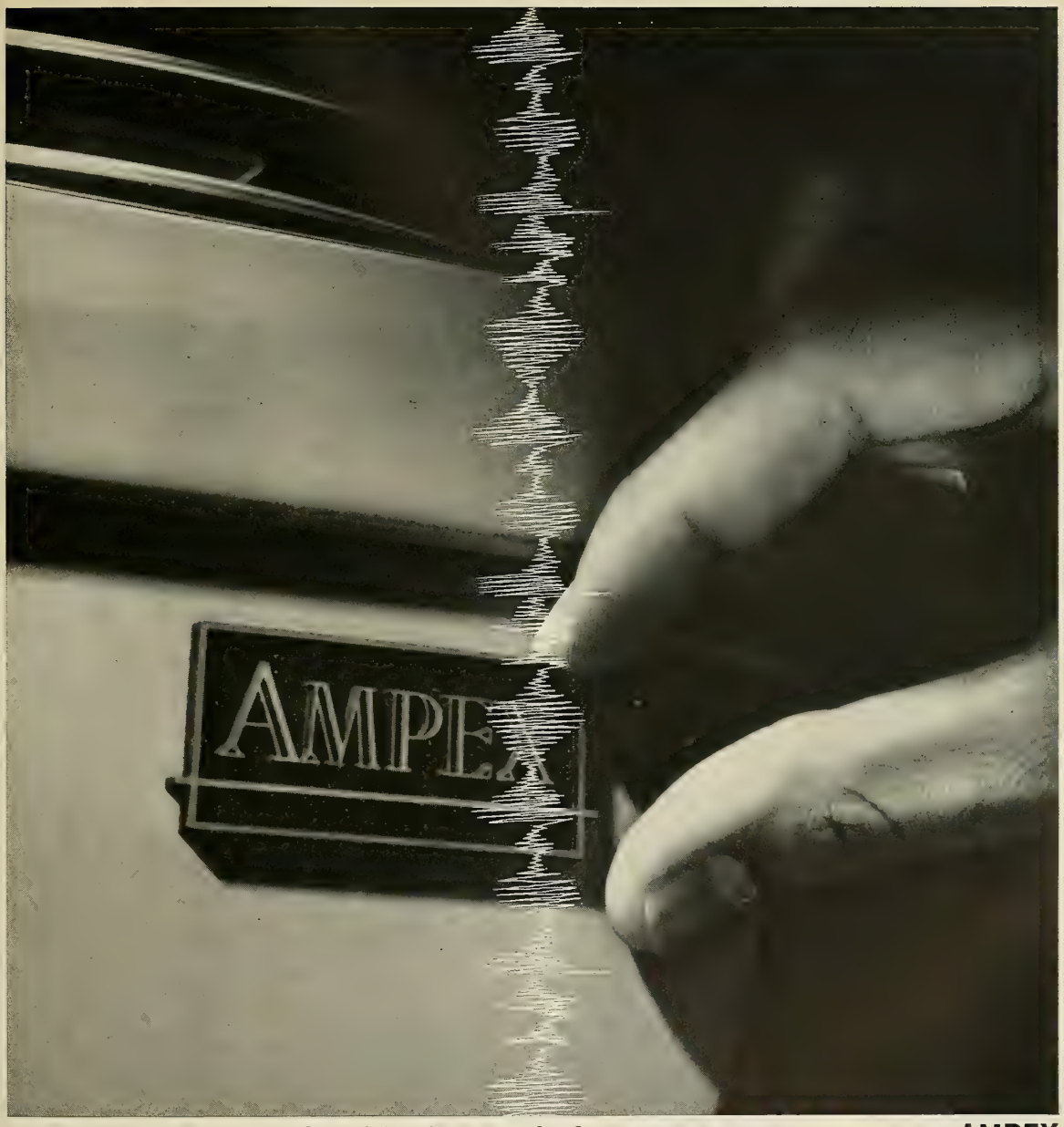


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# NASA Launch Schedule (through 1968)

| SPACECRAFT / MISSION | SITE | VEHICLE |
|---|---|---|
| **1st QUARTER 1963** | | |
| Relay A-16 | AMR | Delta |
| Tiros A-52 | AMR | Delta |
| Syncom A-25 | AMR | Delta |
| AVT-3 | AMR | Thor 3 |
| Ranger P-53 (Lunar Photography) | AMR | Atlas-Agena B |
| Backup S-27A | PMR | Thor-Agena B |
| Vehicle Test | AMR | Centaur 2 |
| Orbiting Solar Observatory S-17 | AMR | Delta |
| Atmospheric Structure Satellite S-6A | AMR | Delta |
| Vehicle Test | AMR | Sat. R&DC-1 SA-4 |
| Backup S-66A, S-48A | AMR | Scout |
| Relay A-19 | AMR | Delta |
| Syncom A-26 | AMR | Delta |
| Ranger P-54 (Lunar Photography) | AMR | Atlas-Agena B |
| **2nd QUARTER 1963** | | |
| Vehicle Test | AMR | Centaur 3 |
| SERT-1 (Electrical Engine) | W. I. | Scout |
| One-Day Mission MA-9 | AMR | Atlas |
| Ranger P-55 (Lunar Photography) | AMR | Atlas-Agena B |
| Tiros A-53 | AMR | Delta |
| Syncom A-27 | AMR | Delta |
| Interplanetary Monitoring Probe S-74 | AMR | Delta |
| Apollo Boiler Plate Abort Test | WSR | Little Joe II |
| **3rd QUARTER 1963** | | |
| Vehicle Test | AMR | Centaur 4 |
| S-17A | AMR | Delta |
| SERT-a (Electrical Engine) | W. I. | Scout |
| International Satellite (UK#2) S-52 | W. I. | Scout |
| Eccentric Orbiting Geophysical Observatory S-49 | AMR | Atlas-Agena B |
| Fire 1 | AMR | Atlas-X259 |
| Gemini | AMR | Titan II |
| Apollo Boiler Plate Abort Test | WSR | Little Joe II |
| One-Day Mission MA-10 | AMR | Atlas |
| Vehicle Test | AMR | Centaur 5 |
| Interplanetary Monitoring Probe S-74A | AMR | Delta 29 |
| International Satellite S-52A | W. I. | Scout 19 |
| Ranger P-56 (Lunar Photography) | AMR | Atlas-Agena B |
| **4th QUARTER 1963** | | |
| Apollo Prototype Command Module Escape | WSR | Little Joe II |
| Vehicle Test | AMR | Centaur 6 |
| Gemini | AMR | Titan II |
| Backup S-49A | AMR | Atlas-Agena B |
| Nimbus A-4 (Meteorology) | PMR | Thor-Agena B |
| Fire 2 | AMR | Atlas-X259 |
| **1964** | | |
| Vehicle Test | AMR | Centaur 7 |
| Gemini | AMR | Titan II |
| Polar Orbiting Geophysical Observatory S-50 | PMR | Thor-Agena B |
| Nimbus A5 | PMR | Thor-Agena B |
| Vehicle Test | AMR | Centaur 8 |
| Gemini | AMR | Titan II |
| Mariner R | AMR | Atlas-Agena B |
| Mariner R | AMR | Atlas-Agena B |
| Nimbus O-1 (Meteorology) | PMR | Thor-Agena B |
| Apollo Prototype Service Module Escape | WSR | Little Joe II |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Vehicle Test | AMR | Centaur 9 |
| Interplanetary Monitoring Probe S-74B | AMR | Delta |
| Gemini | AMR | Titan II |

## MAJOR NASA SPACECRA

**AEROS** (Goddard) First flight '65-'66. Synchronous, Earth-stabilized weather satellite.

**APOLLO** (Houston) Earth orbital flights '64-'65; circumlunar '66; lunar landing '67-'68. Three-man spacecraft for lunar landing program.

**AEROSPACE PLANE** (NASA Hqs-Air Force) Research program for '70; operational date to begin in FY '65. Recoverable booster for Earth orbit and return missions.

**ECHO** (Langley-Goddard) First launch August '60, another planned next year. 135-ft. inflatable sphere for passive communications.

**GEMINI** (Houston) First flight late '63 or early 1964. Two-man spacecraft for long-duration (up to 2 weeks) flights and rendezvous missions.

**LUNAR LOGISTICS VEHICLE** (NASA Hqs) First flights '66-'67. Spacecraft bus to support manned lunar landing program. No development program yet.

**MARINER** (JPL) First successful launch of Venus spacecraft in August expected to fly by planet Dec. 14. Series of unmanned planetary spacecraft for early exploration of Mars and Venus.

**MERCURY** (Houston) Final one-day flight in April '63. First manned spacecraft.

**NIMBUS** (Goddard) First launch late '63. Second-generation, Earth-stabilized meteorological satellite.

**ORBITING ASTRONOMICAL OBSERVATORY** (Goddard) First launch in '64. Large Earth satellite with 36-in. telescope and spectrometer to study stars.



| | | |
|---|---|---|
| Gemini Target | AMR | Atlas-Agena B |
| Nimbus O-2 (Meteorology) | PMR | Thor-Agena B |
| Vehicle Test | AMR | Centaur 10 |
| Apollo Prototype Command Module MAX Q Escape | WSR | Little Joe II |
| Surveyor A | AMR | Centaur 11 |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Backup | PMR | Thor-Agena B |
| Surveyor A | AMR | Centaur |
| Orbiting Astronomical Observatory S-18 | AMR | Atlas-Agena B |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Nimbus A-6 (Meteorology) | PMR | Thor-Agena B |
| Surveyor B | AMR | Centaur 13 |
| **1965** | | |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Nimbus O-3 (Meteorology) | PMR | Thor-Agena B |

| SPACECRAFT / MISSION | SITE | VEHICLE |
|---|---|---|
| Orbiting Astronomical Observatory S-58 | AMR | Atlas-Agena B |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Gemini | AMR | Titan II |
| Gemini Target | AMR | Atlas-Agena B |
| Nimbus O-4 (Meteorology) | PMR | Thor-Agena B |
| Nimbus O-7 (Meteorology) | PMR | Thor-Agena B |
| **1966** | | |
| Nimbus O-5 (Meteorology) | PMR | Thor-Agena B |
| **UNDER STUDY (1964-65)** | | |
| Surveyor | AMR | Centaur 14 |
| Mariner | AMR | Centaur 15 |
| Mariner | AMR | Centaur 16 |
| Surveyor | AMR | Centaur 17 |
| Surveyor | AMR | Centaur 18 |
| Mariner | AMR | Centaur 19 |
| Mariner | AMR | Centaur 20 |
| Backup S-16A | AMR | Delta |
| Vehicle Test and Apollo Boiler Plate | AMR | Sat. R&DC-1 SA-5 |
| Vehicle Test and Apollo Boiler Plate | AMR | Sat. R&DC-1 SA-6 |
| Vehicle Test and Apollo Re-entry | AMR | Sat. R&DC-1 SA-7 |
| Vehicle Test and Apollo Re-entry | AMR | Sat. R&DC-1 SA-8 |
| Vehicle Test and Apollo Low Orbit | AMR | Sat. R&DC-1 SA-9 |
| Vehicle Test and Apollo Low Orbit | AMR | Sat. C-1 SA-10 |
| S-I/S IV B Test | AMR | S-IV B Test |
| S-I/S IV B Test | AMR | S-IV B Test |
| **UNDER STUDY (Late 1965-66)** | | |
| S-IC/Dummy Upper Stages | AMR | Adv. Saturn 1 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 2 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 3 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 4 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 5 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 6 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 7 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 8 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 9 |
| S-IC/S-II/S-IV B | AMR | Adv. Saturn 10 |

**UNDER STUDY (1966-68)**

Apollo—Three or four flights a year. Long duration Earth orbital flights—1966, circumlunar missions (1966-67), manned lunar landing, late 1967-68.

## ND SATELLITE PROGRAMS

**ORBITING GEOPHYSICAL OBSERVATORY** (Goddard) First launch in '64. Series of large Earth satellites using various orbits to study Earth and its space environment.

**ORBITING SOLAR OBSERVATORY** (Goddard) First launch March '62. Earth satellite to study Sun and its radiations.

**RANGER** (JPL) Latest launch October '62. Series of unmanned spacecraft to study the lunar environment through TV and rough-landed instruments.

**REBOUND** (Langley-Goddard) Research and development program for multiple-launched, low-orbit passive communications satellites.

**RELAY** (Goddard) First launch late this year. A spin-stabilized active communications satellite in a medium altitude orbit.

**SURVEYOR** (JPL) First launch in '64. Spacecraft to explore Moon environment by soft-landing instruments on its surface.

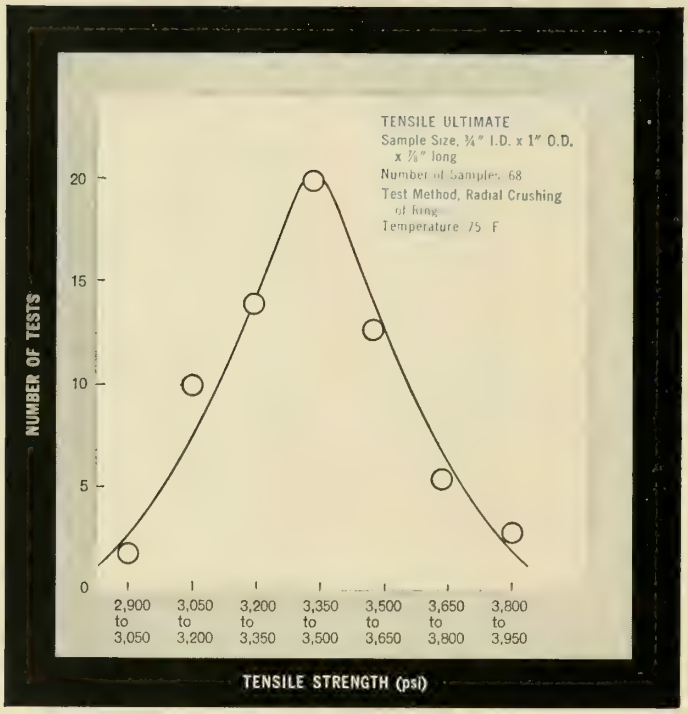
**SYNCOM** (Goddard) First launch in '63. Synchronous orbit active repeater communications satellite.

**TIROS** (Goddard) Latest launch September '62. Spin-stabilized meteorological satellite. First U.S. effort in this area.

**VOYAGER** (JPL) First launch in '66-'67. Unmanned follow-on spacecraft to Mariner to orbit Mars and Venus and inject an instrumented capsule to the planets' surfaces.

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# Economical Future Development is Goal

***Experimental hardware programs aimed at high-energy fluorine upper stages and extremely large powerplants***

ADVANCED RESEARCH experts at NASA are planning a series of experimental hardware programs aimed at demonstrating the feasibility of several new concepts in both extremely large engines and high-energy fluorine upper-stage powerplants.

Adopting the "stitch-in-time" approach, NASA planners hope that research groundwork now will pave the way for economical future development of engines beyond the present state of the art.

Current studies indicate the necessity of a departure from "conventional" engines if the full potential of chemical rockets is to be realized. A booster with 20 to 30 million lbs. of thrust poses a question as to whether a single engine with this thrust would be more desirable than a cluster of high-powered units. Either approach, say NASA experts, obviates following conventional engine technology.

Investigations have uncovered concepts for nozzles with the same performance as the DeLaval configuration, but only one-fifth the length. Thrust-chamber studies have been equally informative.

The problem now is funding exploration into these concepts to generate the data necessary for a future decision on a full-scale development effort.

• **Fluorine problems**—The fluorine/hydrogen engine shows promise of beating hydrogen/LOX systems by 20 $I_{SP}$ units with twice the propellant density. But tackling nature's most reactive element on the scale necessary to support development of an operational upper-stage engine complex has proved the biggest obstacle to a firm program.

Past work at both NASA's Lewis Research Center and Bell Aerosystems has covered thrust chamber designs, nozzle area ratios, ignition and cooling concepts. Those involved feel confident about the handling aspects.

But mundane propellant activities, such as loading and unloading, remain to be demonstrated along with actual flight-weight engines to verify the predicted performance figures. NASA plans to take the first tentative steps in this direction, if adequate funding can be made available.

This would not be a major engine development program, but rather an experimental effort aimed at gathering information to underline the potential of a fluorine upper-stage.

There also are studies into other high-energy combinations—such as diborane-oxygen difluoride and beryllium-oxygen-hydrogen. All are aimed at such high-velocity missions as solar probes, where specific impulse is much more important than storability and other static space problems.

NASA has a series of major engine-development programs in progress, either in the flight-testing stage or extremely close to it. The M-1, F-1, J-2 and RL-10 units account for by far the largest share of available and planned expenditures.

• **M-1 "modernization"**—The liquid-hydrogen/LOX M-1 engine is the only current major propulsion unit without a definite mission. The 1.2-million-lb.-thrust unit received initial funding in a contract to Aerojet-General last January as an upper-stage *Nova* powerplant.

Since then, the *Nova* has passed into relative obscurity, nudging the M-1 off any priority list.

NASA is taking this opportunity to "modernize" the M-1. However, this does not mean any increase in thrust, but rather a stretching of the state of the art in engine design. Major changes in the M-1 program are being planned, and the whole effort is best described as a parallel to the early F-1 effort.

The M-1 is now looked on as filling any requirement in the upper-stage thrust category of 1 to 5 million lbs. or more. NASA officials, aware of the funding squeeze, expect the allotted M-1 dollars to suffer from some inter-program switching.

The sum of $90 million was mentioned when Aerojet landed the development job, and the M-1 was pro-

SYSTEMS PROGRESS



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* A upidiperous turn is a 180° turnabout where the main direction or goal is temporarily forgotten or denied. The word upidiperous is seen regularly, in contracted form, on street signs: NO U TURNS.


gramed for $55.316 million in the original Fiscal '63 breakdown. The funding level is now down to around $25 to $35 million for 1963, and—with the *Nova* delay currently in vogue—this level will probably be maintained through Fiscal '64.

Management of the M-1 has been shifted from Marshall Space Flight Center to Lewis Research Center, together with the *Centaur* program. Lewis is in the process of organizing its team. The move allows Marshall to concentrate fully on the massive lunar launch vehicle program.

• **F-1 committed** — Rocketdyne's F-1, LOX/kerosene, 1.5 million-lb.-thrust engine is firmly committed to the *S-1C* booster on the *Saturn C-5*—an integral part of the high priority *Apollo* program. F-1 development money in fiscal '63 will run between $45 and $50 million, down from the original estimate of $55 million.

The huge engine was initially developed with a *Nova* vehicle in mind, and at least one current super-booster study envisions clusters of 8 to 12 F-1 engines. There are also studies into F-1 derivatives reaching maximum thrust levels of around 2.5 million lbs. each—just about the power region where a completely new engine design is indicated.

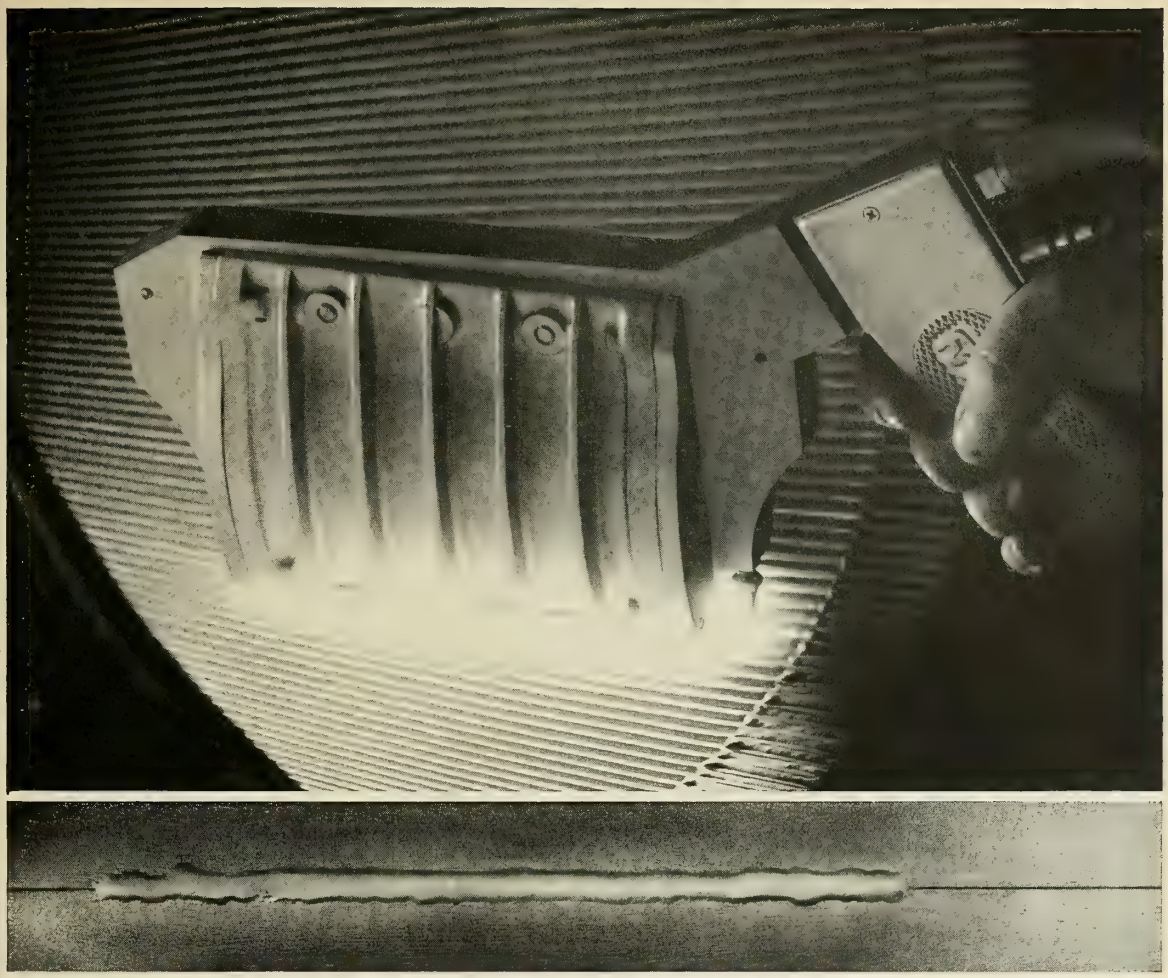
Full-thrust runs of the engine have been made, and units funded under certain vehicle development programs will start arriving at NASA during 1963.

Five J-2 liquid - hydrogen / LOX, 200,000-lb.-thrust engine will be clustered on the *Advanced Saturn's S-II* second stage. A single engine will provide power for the *S-IVB* stage, the third unit of the *C-5* and the second stage of the *C-1B*.

The Rocketdyne engine will be funded at a $40-million level during Fiscal '63, up slightly from the $38 million originally planned. The J-2 probably will continue at this level through Fiscal 1964.

The J-2 program is moving on a schedule aimed at preliminary flight rating tests during the same period as the F-1 engine. Certain aspects of the program have been changed to correlate with the *Saturn C-1B* program.

The Pratt & Whitney RL-10 will use between $25 and $30 million in Fiscal '63, with the same level expected in 1964. Currently part of the *Centaur* vehicle, the 15,000-lb.-thrust units will also power the C-1 second stage. The engines will produce about 40% more specific impulse than kerosene-fueled upper-altitude units. The *Centaur* program is under review by the Lewis Research Center, and full program management organization is not expected to be completed by Lewis until the end of 1962. ⌗



# VERSATILE INFRA-RED BRAZING TOOL HANDLES PRECISION WORK AT TEMPERATURES UP TO 2100°F.

Electric-powered and timer-controlled, Aerojet's new Aeroray Brazing Gun* offers far more control over hand brazing operations than ever before possible. Developed to perform delicate repairs to thin-walled sections (.010 - .020 inch) of missile thrust chambers, the gun focuses high density infra-red energy into a 5 inch line only .100 inch wide, delivering time-controlled temperatures up to 2100° F. ■ The Aeroray Brazing Gun has a power density output of 2400 watts per square inch, and can melt a braze alloy such as Coast #62 in less than 45 seconds. This speeds up brazing dramatically and permits use of inexpensive braze alloys. Just as important, close control of the heat output reduces discoloration and all but eliminates accidental burn damage to the part. ■ Made of aluminum, the Aeroray Brazing Gun weighs only 3 pounds. Operation is so simple unskilled personnel can be trained in about 15 minutes. Power requirement is 230 volts A.C. Heat is generated by a standard quartz lamp and focused by reflectors. Brazing takes place in an envelope of argon gas triggered through the gun. ■ Price of the complete Aeroray Brazing Gun (including timer), $975.00 plus shipping and handling. For more information, contact Aerojet-General® Corporation, P.O. Box 296-J, Dept. 50, Azusa, California.

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GENERAL TIRE
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*PATENT APPLIED FOR

The design is thousands of years old. Called "Man," it has evolved reasonably efficient techniques for coping with weather, saber-toothed tigers, city traffic, floods and income taxes. □ But now it faces a problem of a new order of magnitude...survival beyond the protective cocoon of the earth's environment. In this airless, weightless, radiative region, man needs a big assist. Douglas is working to provide it. □ Douglas scientists are far along in studies of ecological systems for the maintenance of human life under extra-terrestrial conditions. These research areas cover the varied life and physical sciences and engineering systems which are involved. They range from psycho-physiological analyses to the actual planning of the establishment and support of cities on the moon.

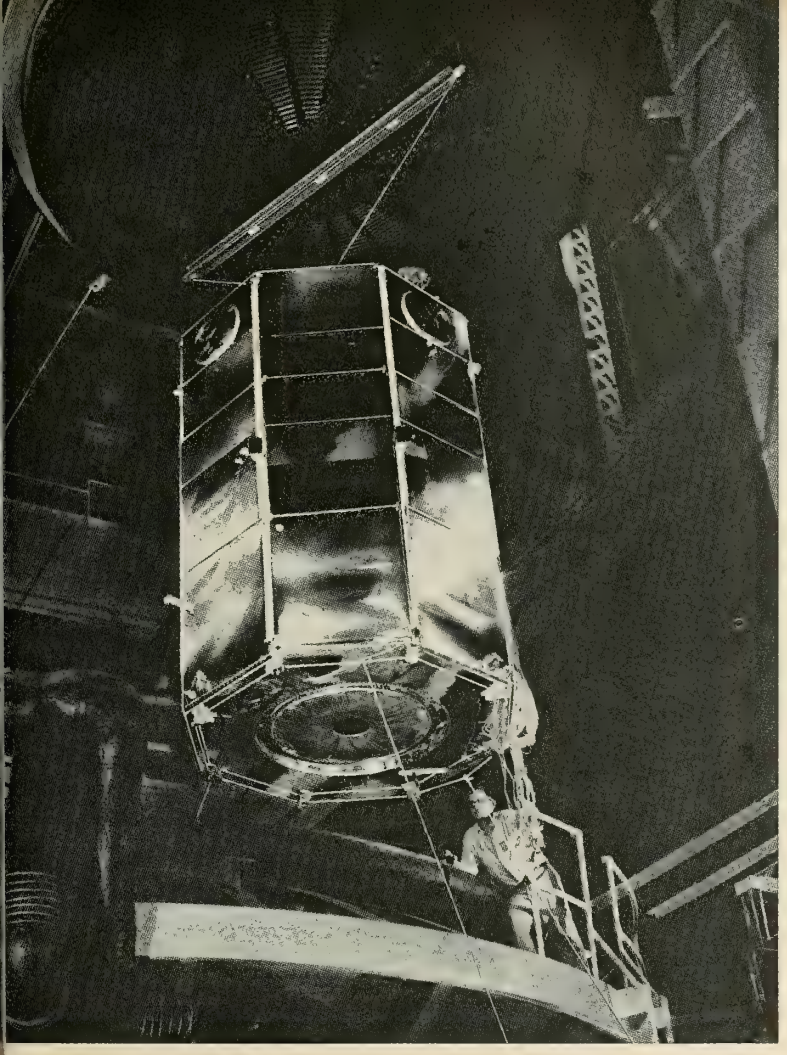
## EARTH'S MOST COMPLICATED SYSTEM

### ...AND HOW DOUGLAS IS ORIENTING IT TO OUTER SPACE

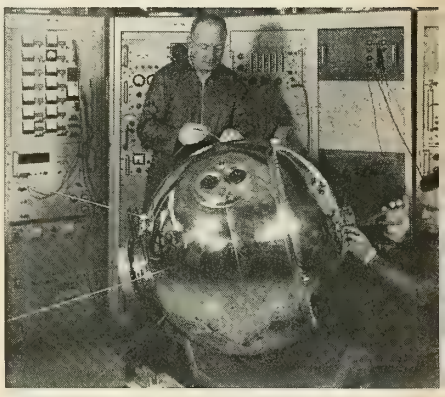


Development of improved man-machine relationships and detailed planning of the giant vehicle systems that are involved in space exploration are among more than 500 research and development programs now under way at Douglas.

DOUGLAS



**NASA/**
scientific
satellites



**ABOVE:** *Technicians work on S-6.*
**LEFT:** *Structural model of Orbiting Astronomical Observatory (OAO) is lowered into space chamber at Grumman's Long Island plant for environmental testing.*

# Big Projects Planned Despite Cutback

***One-fourth slash in FY '63 budget may set pattern —but pricetag through 1970 could still top $1 billion***

OFFICIALS of NASA's scientific satellite program are planning major future projects such as solar orbiters and *Radio Astronomical Observatory (RAO)* despite evidence of some program de-emphasis by the space agency's top management.

A 25% reduction in the program's Fiscal '63 budget has been decreed by NASA headquarters.

This cuts funding from the $195 million approved by Congress to $140 million.

About $84 million will be spent for spacecraft and support, $37 million for launch vehicles, $11.7 million for sounding rockets and the remainder for advanced research and technology.

Top officials deny that the space science program is being de-emphasized in favor of the manned spaceflight project.

Associate Administrator Robert C. Seamans Jr. told MISSILES AND ROCKETS "it is our intention to have a total NASA program with reasonable funding for manned, unmanned scientific and space application projects."

It is clear, however, from the 1963 experience and the tough overall budgetary problems facing the space agency, that further reductions in space science funds can be expected.

Program officials told M/R that if cuts are required, the 1963 pattern will be followed. No major programs, such as the big observatories, will be killed, but some delay in scheduling will result. Hardest hit will be the small scientific satellite efforts and the sounding rocket program (see chart).

Despite the clouded money picture, program officials are going ahead with plans for a long list of future projects.

*RAO* will be launched in 1965-66.

The solar orbiters and solar probes would come roughly in the same time period. A variety of near-Earth probes are also being considered.

• **Growing toward $1 billion**—Officials estimate that development, operation and evaluation of the planned U.S. scientific satellite program will cost well over $1 billion through 1970. Most of this effort will be managed by Goddard Space Flight Center, but some of the solar probe work is being done, and may be done in the future, by the Ames Research Center.

The great growth area and the heart of the program are the space observatories. Besides the planned *RAO*, three are now well conceived and well along in development: *OSO, (Orbiting Solar Observatories); OAO, (Orbiting Astronomical Observatories);* and *OGO (Orbiting Geophysical Observatories).*

All observatories now under development probably will be used throughout a full solar cycle (11 years).

Projects requiring highly advanced scientific satellites are included in the President's FY '64 budget request, and satellite costs are expected to exceed $140 million. This figure, according to NASA estimates, will continue to grow in FY '65 and level off in FY '66. The observatory programs will level off at that time at about $150 million per year —and hold at this figure at least through 1970 and probably through 1974.

International scientific satellite programs are expected to receive increased interest during the next decade; however, U.S. funding will remain at a relatively low but constant level. These are cooperative projects, with the U.S. primarily offering its technical skills and its launch vehicles.

The three-vehicle "weaning" process, started with the United Kingdom satellite series, also is expected to continue. That is, the U.S. builds the first vehicle and the associated country performs much of the experimental-package design under NASA guidance. The second vehicle is designed by the associate under NASA guidance and is largely fabricated in the U.S. The third vehicle is designed and is built by the associate while NASA continues to assist as a consultant.

• **OSO and follow-on**—Seven more Earth-orbiting observatories, based on the came configuration as the *S-16a (OSO-1)* vehicle launched successfully at Cape Caneveral last April, will be employed to make solar-oriented experiments. The stabilized crafts will continually make observations of the Sun and the solar atmosphere. Measurements will be made in the X-ray, ultraviolet, and infrared portions of the spectrum.

Solar orientation is accurate to ±1 min. of arc.

## NASA COST ESTIMATES FOR EXISTING SCIENTIFIC SATELLITE PROGRAMS (MILLIONS)

| SATELLITE PROJECT OR SERIES | THROUGH FY 1961 | FY 1962 | FY 1963 | FY 1964 (EST.) | THROUGH COMPLETION (EST.) | TOTAL (EST.) |
|---|---|---|---|---|---|---|
| **OSO (Series)*** | | | | | | |
| Spacecraft (8) and Support | $ 5.5 | $ 3.0 | $ 7.2 | $ 12.6 | $ 19.6 | $ 47.9 |
| Delta Launch Vehicles (7) | ..... | 2.5 | 3.4 | 5.0 | 6.6 | 17.5 |
| **OAO (Series)** | | | | | | |
| Spacecraft (5) and Support | 7.2 | 34.8 | 35.8 | 50.0 | 53.7 | 181.5 |
| Atlas-Agena Launch Vehicles (5) | ..... | 3.4 | 4.3 | 18.1 | 43.2 | 69.0 |
| **OGO (Series)** | | | | | | |
| Spacecraft (9) and Support | 5.2 | 20.9 | 28.3 | 48.1 | 65.5 | 168.0 |
| Atlas-Agena (5) and Thor-Agena (4) Launch Vehicles | ..... | 5.1 | 17.1 | 19.4 | 20.4 | 62.0 |
| **Energetic Part. Sat.*** | | | | | | |
| Spacecraft (2) and Support | 2.1 | 0.8 | 1.0 | 0.6 | ..... | 4.5 |
| Delta Launch Vehicles (0) | ..... | ..... | ..... | ..... | ..... | ..... |
| **Atmos. Structure Sat.*** | | | | | | |
| Spacecraft (4) and Support | 2.8 | 1.0 | 1.8 | 2.8 | 1.9 | 10.3 |
| Delta Launch Vehicles 3) | ..... | ..... | 2.5 | 2.5 | 2.5 | 7.5 |
| **Topside Sounder (U.S.)** | | | | | | |
| Spacecraft (2) and Support | 1.2 | 0.6 | 1.0 | 0.2 | ..... | 3.0 |
| Scout Launch Vehicle (1) (Will share 2nd Scout with 2nd Polar Iono. Beacon Sat.) | 1.0 | ..... | ..... | ..... | ..... | 1.0 |
| **Topside Sounder (Canada)** | | | | | | |
| Support only | 0.04 | 0.04 | 0.1 | ..... | ..... | .18 |
| Thor-Agena B Launch Vehicles (2) | 3.2 | 8.1 | 1.8 | ..... | ..... | 13.1 |
| **Interplanetary Monitoring Probe** | | | | | | |
| Spacecraft (7) and Support | ..... | 1.9 | 2.3 | 3.0 | 5.3 | 12.5 |
| Delta Launch Vehicles (7) | ..... | ..... | 5.2 | 5.0 | 7.3 | 17.5 |
| **International Iono. Sat. (UK-1)** | | | | | | |
| Spacecraft (2) and Support | 1.1 | 1.3 | 0.5 | ..... | ..... | 2.9 |
| Delta Launch Vehicle (0) | ..... | ..... | ..... | ..... | ..... | ..... |
| **(UK-2)** | | | | | | |
| Spacecraft (2) and Support | ..... | 1.3 | 1.3 | 0.6 | ..... | 3.2 |
| Scout Launch Vehicles (2) | ..... | ..... | 2.0 | ..... | ..... | 2.0 |
| **Polar Ionosphere Beacon Satellite** | | | | | | |
| Spacecraft (2) and Support | ..... | 0.8 | 0.4 | 0.2 | ..... | 1.4 |
| Scout Launch Vehicles (2) | ..... | 1.3 | 0.7 | ..... | ..... | 2.0 |
| **Interplanetary Probe** | | | | | | |
| Spacecraft (4) | ..... | ..... | 3.5 | 9.6 | 5.0 | 18.1 |
| Delta Launch Vehicles | ..... | ..... | ..... | 3.4 | 6.6 | 10.0 |
| **Solar Probe** | | | | | | |
| Spacecraft (4) | ..... | ..... | 0.5 | 14.8 | 46.3 | 61.6 |
| Atlas-Agena Launch Vehicles (4) | ..... | ..... | ..... | 0.2 | 32.4 | 32.6 |
| **SPACECRAFT AND SUPPORT:** | $25.14 | $66.44 | $ 83.7 | $142.5 | $197.3 | $515.08 |
| **LAUNCH VEHICLES** | 4.2 | 20.4 | 37.0 | 53.6 | 119.0 | 234.2 |
| **TOTAL:** | $29.34 | $86.84 | $120.7 | $196.1 | $316.3 | $749.28 |

* Note: Where number of Delta launch vehicles differs from number of spacecraft, difference indicates vehicles funded in Delta development program.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Sounding Rockets** | $ 7.3 | $ 8.9 | $ 11.5 | $ 16.0 | | |
| Sustaining University Program (Research Grants) | ..... | $12.00 | $ 30.0 | $ 60.0 | | |

# Immediate Boeing openings on

# SATURN



The advanced Saturn will be the free world's largest rocket and one of the first developed specifically for scientific space programs. Boeing has been awarded primary developmental, building and test responsibility for the advanced Saturn first stage booster. This uniquely challenging program offers outstanding long-range career opportunities for engineers and scientists.
We suggest that you fill in the professional application form which begins below and continues on the following page.

## MAIL FORM TODAY

PROFESSIONAL POSITION APPLICATION
(All replies held in strict confidence)

Date of this Application_____

Name_____
LAST FIRST MIDDLE (USE NO INITIALS)

Social Security No._____

Present Address_____
NO. STREET

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CITY ZONE STATE

Telephone No._____

Date of Birth_____ U.S. Citizen_____

Male_____ Female_____ Marital Status_____

No. of Children_____ Other Dependents_____

U.S. Veteran_____ Entry Date_____

Discharge Date_____

Type of Discharge_____

Full Name of Spouse_____

Employer_____

Previous Boeing Employee?_____

If the answer to following two questions is "yes," explain on supplementary sheet:

1) Have you any physical defects?_____

2) Have you ever been arrested (except traffic and juvenile)?

_____

HIGHER EDUCATION

| College and Location | Dates Attended | Degree and Major |
|---|---|---|
| 1. | | |
| 2. | | |




The huge advanced Saturn will stand about 350 feet high and measure 33 feet in diameter. Its takeoff weight is estimated at approximately six million pounds. The Boeing first-stage booster, powered by a cluster of five engines, will have a total thrust of 7.5 million pounds.

Boeing's new Saturn Booster Branch has a number of long-range openings offering exceptional ground-floor opportunities. Immediate assignments are available to engineers in the following fields of interest: aerodynamics, structures, electronics, propulsion, systems test, aeronautical, reliability, vibrations, acoustics, loads, support equipment, high vacuum and electrical, as well as cryogenics, stress analysis and thermodynamics.

Assignments will be in New Orleans or Huntsville, Alabama. Other Saturn openings — as well as assignments on such additional Boeing missile and space programs as the Minuteman ICBM and the Dyna-Soar boost-glide vehicle — are available at Seattle, Cape Canaveral and Vandenberg AFB. Boeing pays travel and moving allowances to newly-hired engineers.

You'll find space in the application below to indicate your special interests. Fill in and mail today.

**BOEING**

---------- **FORM BEGINS ON PREVIOUS PAGE** ----------

EMPLOYMENT HISTORY (Attach Resume)

| Firm Name and Address | Base Pay 40 hr/Wk | Dates Employed Month/Year |
|---|---|---|
| 1. Position & Duties | | |
| 2. Position & Duties | | |
| 3. Position & Duties | | |
| 4. Position & Duties | | |

REFERENCES. Give full names, occupations and addresses. Professional (previous supervisor preferred):

1.

2.

Character (other than relatives or former employers):

1.

2.

LIST TYPE OF WORK PREFERRED UPON EMPLOYMENT:

Have you ever been cleared for classified military information_____. If yes, give date, level and company.

May we contact your former and present employer prior to completion of employment negotiations? Yes_____ No_____
If "yes," I authorize, without liability, the release of all employment and personal information.

SIGN YOUR NAME HERE

The Boeing Company is an equal opportunity employer.

RETURN TO: MR. W. L. HAYS, THE BOEING CO.
P. O. Box 26088 - MSF, New Orleans, La.

## SUMMARY OF CURRENT NASA SCIENTIFIC SATELLITES AND LAUNCH SCHEDULE

NASA

| SATELLITE PROJECT OR SERIES | CENTER | PROJ. MANAGER | BOOSTER | VEHICLE PRIME | LAUNCH SCHEDULE |
|---|---|---|---|---|---|
| **Orbiting Solar Observatories** | GSFC | Dr. John C. Lindsay | —— | | |
| OSO-1 (S-16) | | | Delta | Ball Bros. | Mar. '62 |
| OSO-2 (S-17) | | | " | (OSO-1 to 4) | 1-Q '63 |
| OSO-3 (S-57) | | | " | | 3-Q '63 |
| OSO-4,-5 | | | " | ? | '64 |
| OSO-6-7 | | | " | (OSO-5 to 8) | '65 |
| OSO-8 | | | " | | '66 |
| Adv. OSO (4 vehicles) | | | Atlas-Agena | | '66-'67 |
| **Orbiting Astronomical Observatories** | GSFC | Robert R. Zeimer | Atlas-Agena | Grumman | |
| OAO-1 (S-18) | | | | | '64 |
| OAO-2 (S-58) | | | | | '65 |
| OAO-3 (S-68), OAO-4 | | | | | '66 |
| OAO-5 | | | | | '67 |
| **Orbiting Geophysical Observatories** | GSFC | Wilfred E. Scull | | STL | |
| EGO-1 (S-49) | | | Atlas-Agena | | 3-Q '63 |
| EGO-2 | | | " | | 4-Q '63 |
| EGO-3 | | | " | | '64 |
| EGO-4 | | | " | | '65 |
| EGO-5 | | | " | | '66 |
| POGO-1 (S-50), POGO-2 | | | Thor-Agena | | '64 |
| POGO-3,-4 | | | " | | '65 |
| **Energetic Particles Sat.** | GSFC | | Delta | GSFC in house | |
| S-3 (Explorer XII) | | P. Butler | | | Aug. '62 |
| S-3a | | Paul G. Marcotte | | | Oct. '62 |
| **Atmospheric Structure Sat.** | GFSC | N. W. Spencer | Delta | GSFC in house | |
| S-6 | | | | | 3-Q '62 |
| S-6a | | | | | 1-Q '63 |
| ? | | | | | '64 |
| ? | | | | | '65 |
| **Topside Sounder (U.S.)** | GSFC | John E. Jackson | | | |
| S-48 | | | Scout | Airborne Instruments Lab. | 1-Q '63 |
| S-48a | | | —— | | ? |
| **Interplanetary Monitor Probe** | GSFC | P. Butler | Delta | GSFC in house | |
| IMP-1 (S-74) | | | | | 3-Q '63 |
| IMP-2 (S-74a) | | | | | 4-Q '63 |
| IMP-3 (S-74b), IMP-4 | | | | | '64 |
| IMP-5,-6 | | | | | '65 |
| IMP-7 | | | | | '66 |
| **United Kingdom** | GSFC | | | GSFC in house/UK | |
| S-51 (UK-1) | | R. C. Bauman | Delta | | April '62 |
| S-52 (UK-2) | | Emil Hymonwitz | Scout | Westing-house | 2-Q '63 |
| S-53 (UK-3) | | | " | UK | |
| **Canada (Topside Sounder)** | GSFC | John E. Jackson | Thor-Agena | Defense Research Telecom. Estab., Canada | |
| S-27 (Alouette) | | | | | Sept. '62 |
| ? | | | | | 1-Q '63 |
| **Polar Ionospheric Beacon** | NASA Hqrts. & GSFC (Monitor) | Frank T. Martin | Scout | Applied Physics Lab. Johns Hopkins Univ. | |
| S-66 | | | | | 4-Q '62 |
| S-66a | | | | | 1-Q '63 |
| **Interplanetary Probe** | Ames RC | | | | |
| Pioneer: (1) | | | Delta | STL | '64 |
| (2) | | | | | '65 |
| (1) | | | | | '66 |
| **Solar Probes** | Ames RC | | Atlas-Agena | ? | |
| (4 vehicles) | | | | | '66-'67 |

Ball Brothers Research Corporation holds a prime contract for the first four standardized spacecraft.

In FY '62 first funds were made available for study contracts leading to a conceptual design for an advanced *OSO* vehicle. Expected to weigh roughly 1000 lbs., the larger system will be capable of carrying heavier and more varied instruments for solar experiments. It will have an offset capability to permit study of the solar corona and a variable scan capability for selective solar-region studies.

Ball Bros., Space Technology Labs., and Republic Aviation are under contract for the conceptual design due to be submitted in February to Goddard. First launch is currently scheduled for 1966.

• **OAO's sophisticated**—Grumman Aircraft Engineering Corporation is system contractor to Goddard for the first five *Orbiting Astronomical Observatories*. While each will use a standardized shell, the spacecraft optical systems and stabilization subsystems will vary considerably, particularly among the first three vehicles.

Each vehicle will carry extremely sophisticated data storage, handling, transmission and reception subsystems.

The first *OAO* will carry two major experiments. One will study the celestial sphere in three ultraviolet ranges, using three broadbound television photometers. The other will record the brightness of more than 200,000 stellar bodies.

In this first system, optics will be small, experiments simple, and pointing accuracy will be to 1 min. of arc.

*OAO-2* will carry a fast 36-in. Cassegrain telescope with a large-aperture spectrophotometer. It will be provided with a fine pointing system accurate to 1 sec. of arc. The scope employs coated beryllium optics and reportedly offers a factor-of-ten weight improvement over more conventional optical systems. The 700-lb. telescope will collect spectrophotometric data on selected stars, nebulae, and galaxies in the range of 912-4000 Angstroms.

*OAO-3* will have an even finer pointing accuracy—to 0.1 sec. of arc. It will carry a 30-in. telescope and will observe the absorption spectrum of interstellar in two regions, 800-1500A and 160-3000A. However, if *OAO-1* should fail, this vehicle may serve as its backup.

Future launches probably will be made every six to nine months, with the goal of achieving at least one good launch and orbit per year. As many as 12 vehicles may ultimately be required.

• **Geophysical studies** — *Orbiting Geophysical Observatories* will be launched at a rate of roughly three per year in an attempt to always have one highly eccentric *(EGO)* and one polar



**Spring-like** Koiled Kords retractile cords give the efficiency and reliability necessary in complex power and communications networks at Cape Canaveral. Portion of Mercury Spacecraft is shown in this National Aeronautics and Space Administration photo.

# Tangle-free Koiled Kords* help make any product "go"

Space exploration is demanding enough, without having to put up with tangled power and communications cords. That's why designers of NASA systems make wide use of Koiled Kords retractile cords, for products and parts of products that move.

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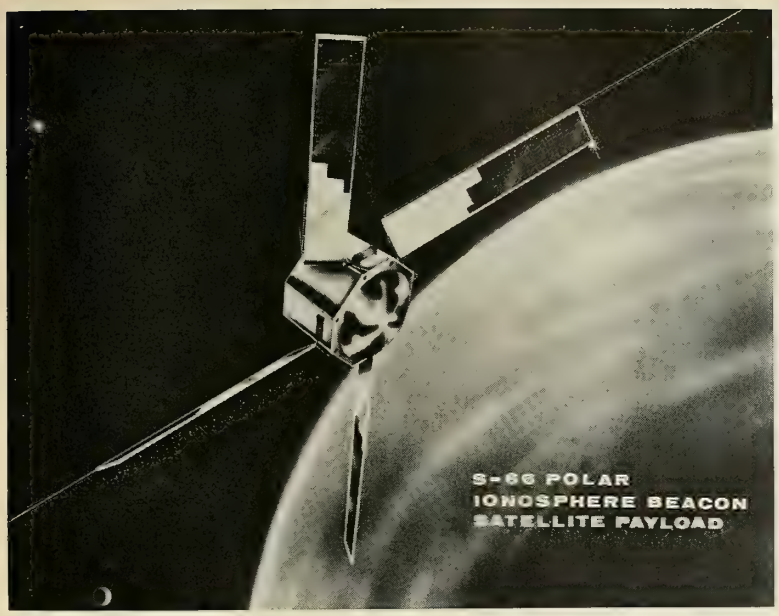
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Circle No. 1 on Subscriber Service Card




*(POGO)* orbiting observatory in operation at the same time. These will be employed to make correlated geophysical measurements in the Earth's atmosphere, the magnetosphere, and cislunar space.

The *EGO* will be launched into a roughly equatorial orbit and its high eccentricity will carry it through the radiation belts and out to 40,000 km. apogee. *POGO*, also somewhat eccentric, will go out to about 1000 km. and will cover the upper atmosphere and ionosphere. Emphasis, however, will be in the polar regions.

Experiments will be varied considerably and will include such areas of study as solar breeze, energetic electron intensities, energy distribution, solar cosmic ray fluxes, and galactic cosmic radiation.

Some vehicles may carry from 20 to 50 different experiments. Much of the data acquired will be analyzed to determine the hazards in space which might be encountered by manned vehicles.

System prime contractor is Space Technology Laboratories, Inc.

None of the *OGO* series will be limited to U.S. experiments. It is believed that the first *POGO* will carry a French experiment package and that other nations will generate tasks and hardware for inclusion in later launches.

To support this series of observatories, two 85-ft. dish antennas will be installed—one in Alaska, the other at Rosman, N.C.—plus three 40-ft. dishes at widely dispersed points in the Southern Hemisphere.

• **Energetic particles**—The first *(Explorer XII)* in this two-vehicle series to measure systematically solar activity and cosmic ray phenomena, and to correlate the activity of energetic particles about the Earth, was launched successfully in April, 1961. The second *(Explorer XV)* was orbited last month to assist in determining the intensity and extent of the man-made belts resulting from the Johnston Island nuclear tests.

The orbital path extends from a perigee of about 180 miles to an apogee of 47,000 miles.

System development and management is under Goddard Space Flight Center.

• **Atmospheric studies** — Four vehicles will be built by Goddard to study the characteristics of the Earth's atmosphere and near space (from 160-700 miles altitude).

These satellites, beginning with *S-6a*, will measure density, composition, pressure, and temperature. These parameters will be studied with respect to variations with time and latitude.

• **Topside sounders**—*S-48* and *S-27* are the U.S. fixed-frequency and Canadian swept-frequency satellites. Both will be used in a coordinated program to investigate the propagation characteristics of the ionosphere from above.

The U.S. system will employ a sounding technique using six fixed frequencies. *S-27* will continuously sweep over a frequency range of 2-15 mc.

Both satellites have three primary goals: to measure electron distribution in space and the time between maximum electron density height of the F2 layer and the height of vehicle orbit; to determine the electron density in the vicinity of the transmitter; to estimate cosmic noise level in the 3-9 mc *(S-48)* or 2-15 *(S-27)* frequency ranges.



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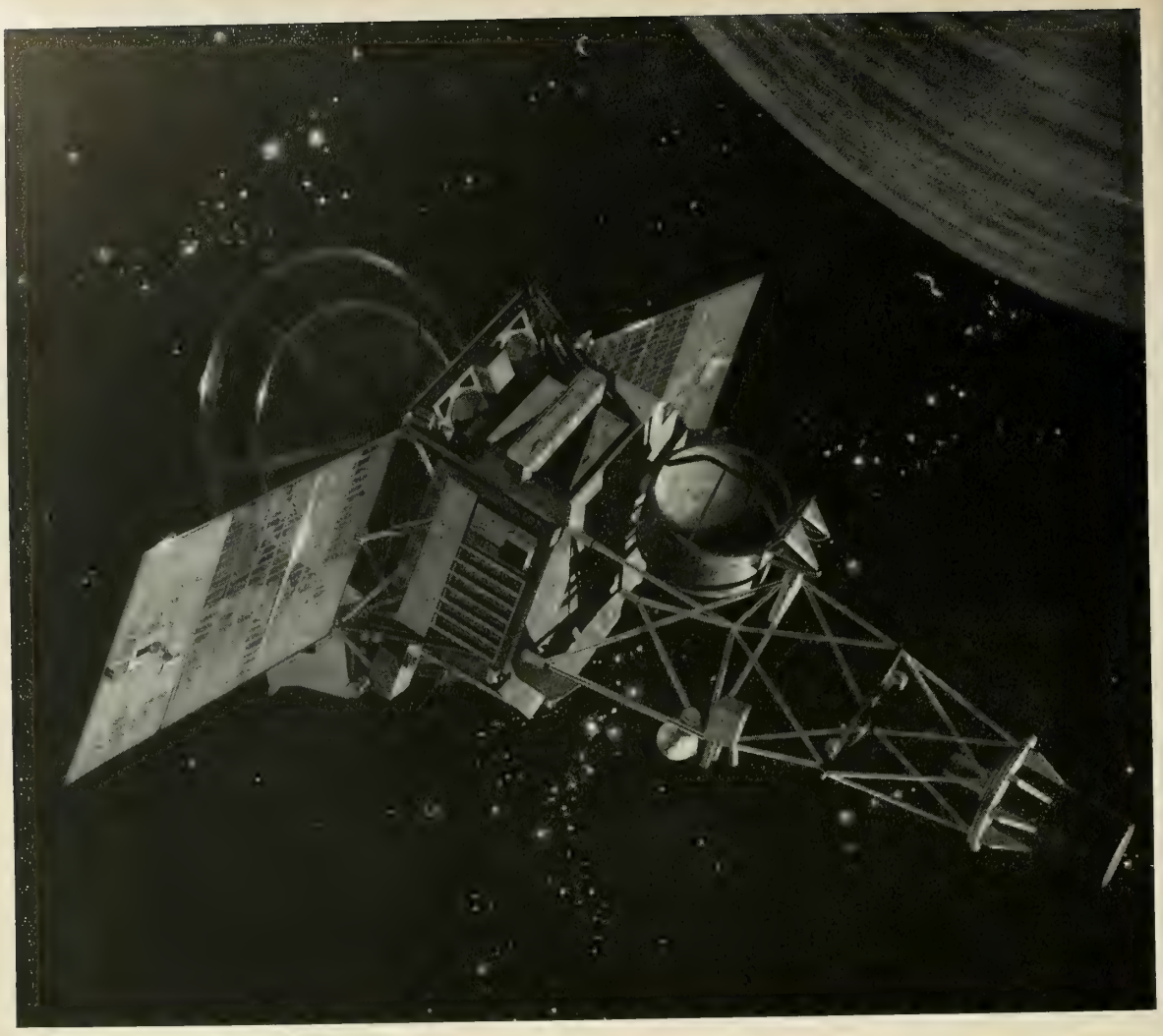
MMH
(monomethyl hydrazine)
has
ideal
storability

For space propulsion and control systems, you'll want to examine the storage aspects of MMH . . . another member of the Olin family of hydrazine fuels. Monomethyl hydrazine's ideal storability means that its purity will remain the same under all expected environmental conditions for extended durations. Also, this important feature can make hardware requirements simpler and can facilitate handling with no danger from impact or friction.

MMH is just one of the pure hydrazine fuels available from Olin in drum and tank car quantities. Anhydrous hydrazine and UDMH (unsymmetrical dimethyl hydrazine) are the others. And Olin can make a hydrazine blend with the built-in specific properties that you require. Write us for the latest literature on MMH and other hydrazine fuels. Olin is the major producer of all hydrazine fuels and blends. Olin Mathieson Chemical Corp., Chemicals Division, 745 Fifth Ave., New York 22, N. Y.

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Olin
CHEMICALS DIVISION



# How to power Venus-bound space probes?

Ryan Aerospace is producing lightweight solar panels which will support thousands of tiny photoelectric cells to harness the sun's energy in space. The cells will generate the electrical power needed for the controls, experimental and communications systems of Venus space probes and earth satellites.

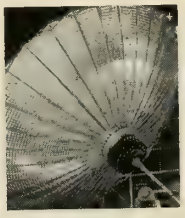
With broad experience in systems management, Ryan engineers are developing power systems, communications systems, and advanced space structures to meet the requirements of space vehicle programs. These capabilities are geared to *fast reaction time* in keeping with the demands of planetary orbits and sudden shifts in program schedules.

Flexible, fast-moving Ryan is also making significant contributions in the areas of V/STOL aircraft, Doppler sensing and navigation systems, and Flex Wing applications. And Ryan is the world's largest producer of jet target systems for the Armed Services.

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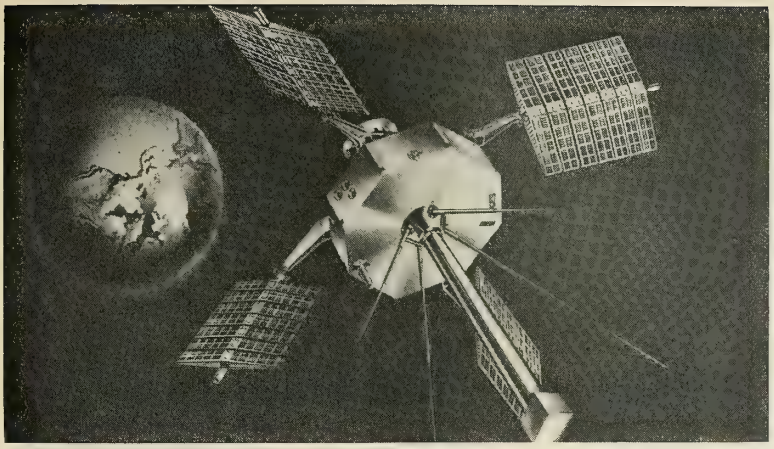
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*ARTIST'S CONCEPT of Explorer XV (S3a) Energetic Particles Satellite in Earth orbit. Satellite was orbited Oct. 28 from Cape Canaveral.*

• **Apollo support**—*IMP*, the *Interplanetary Monitoring Probe*, will be employed to determine the extent of the radiation hazard that might be encountered by future *Apollo* space vehicles.

Seven satellites in all will be launched from 1963 to 1966. Each will have a highly eccentric orbit extending out to 180,000 nautical miles and as close to Earth as 110 n. mi.

NASA scientists expect the IMP series to help provide a means for solar-flare prediction and to increase fundamental knowledge of solar-terrestrial relationships. The program will permit continuous monitoring of the cislunar radiation environment and at the same time obtain measurements of the interplanetary magnetic field quiescent characteristics and the relationship of the special magnetic field to solar particle fluxes.

• **UK satellites** — Three satellites are to represent the United Kingdom/U.S. joint venture. The first, *Ariel*, or *UK-1*, was launched successfully last April. *UK-2* and *UK-3* are scheduled for launch in 1963 and 1964, completing the effort.

*UK-1* was designed to determine the electron temperature and density and the ion mass spectrum at altitudes from 300-1000 km. above the Earth. Seriously affected by the radiation belt generated during the recent Johnston Island nuclear tests, transmissions became sporadic because of a marked decrease in power. However, recent NASA reports indicate the satellite is now transmitting well for periods of about 10 days at a time (while exposed to the maximum amount of solar radiation).

*UK-2* will measure galactic noise in the 0.75-3.0 mc range. It also will determine ozone content and carry a micrometeoroid detector of new design. Ozone vertical distribution will be determined by employing solar-ray attenuation measurements (2500-4000 Angstroms).

*UK-3* experiments are now being U.K. and U.S. scientists to further supplement data obtained by the first two satellites.

• **Ionosphere beacon**—Last of the first generation ionospheric study satellites is *S-66, the Polar Ionosphere Beacon Satellite*. Together with *Explorer VIII, Ariel (S-51), Alouette (S-27)*, and the U.S. Topside Sounder *(S-48)* the *S-66* experiments should broaden presently planned coverage of this near-Earth region.

Essentially, the spacecraft will determine the total electron content in a cross-section between it and the ground as a function of latitude, season, diurnal and time. It will also relate gross ionospheric behavior with ionization-producing solar radiation.

A major emphasis in this project will be to study conditions in the ionosphere that disrupt communications and to study propagation anomalies in the 20-360 mc frequency range.

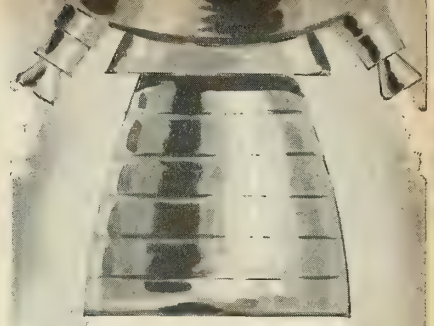
The next step, according to NASA, in the broad study of this region will be to combine some of the major observation techniques employed in earlier These would then be employed in the satellites into one test vehicle series. ionosphere over at least one-half a solar cycle (5½ years) at a high altitude.

• **Sounding rockets** — NASA requirement for its sounding-rocket program are growing at an ever-increasing rate. More than 90 flights were scheduled in 1962 and about 110 are planned for 1963.

Principal goals in this national sounding rocket program are studies of the upper atmosphere, the ionosphere, the geomagnetic field, energy particles and a variety of astronomical studies



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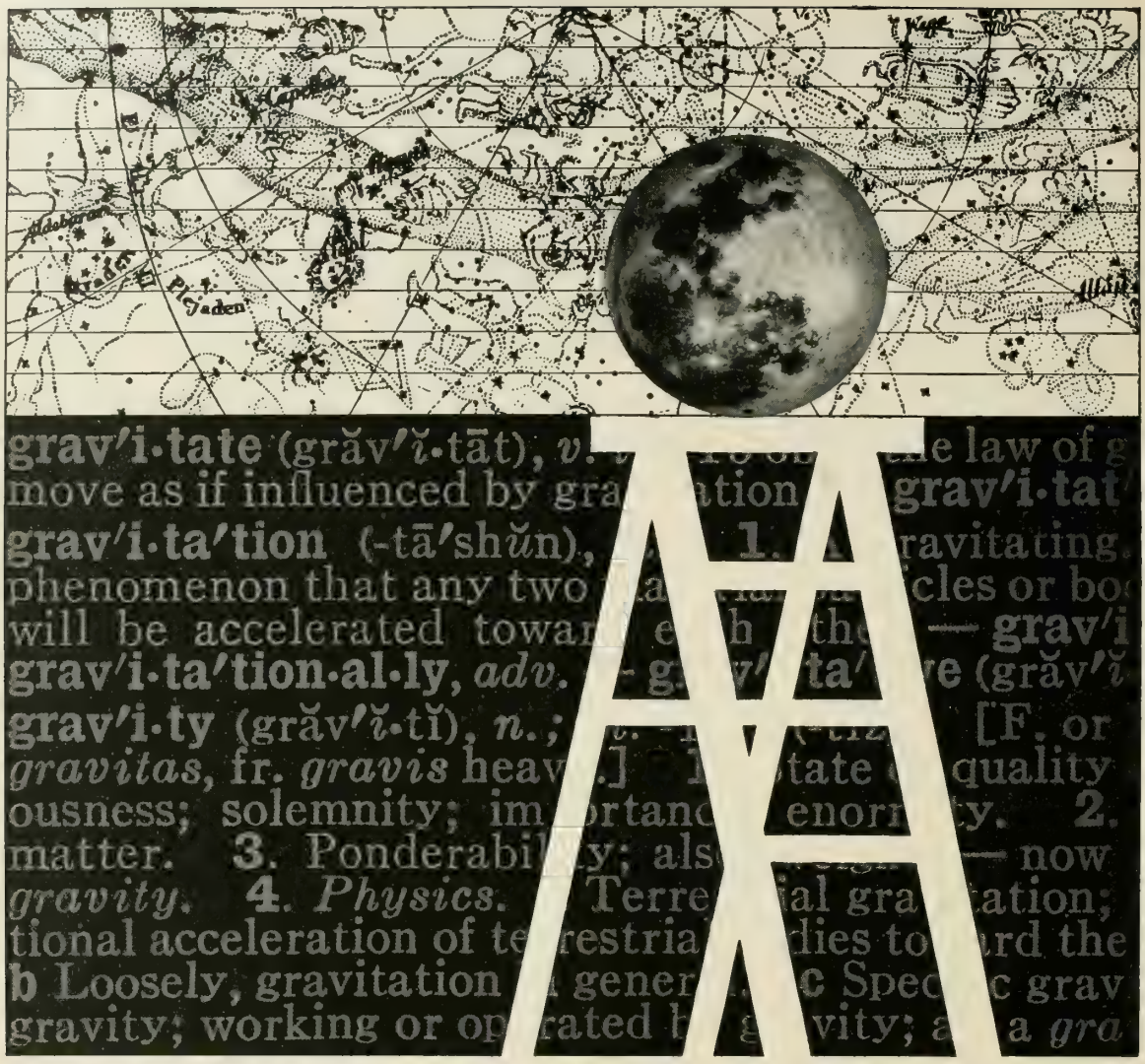


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(vertical soundings to about one Earth radius).

Rockets offer a great advantage over orbiting vehicles as far as cost is concerned and they can be used to study the low altitudes.

For example, one ultimate goal is to develop a reliable ionosphere-content prediction method. Rockets are ideal for studying the D-layer (40-60 miles altitude) and this region is probably most significant as far as radio interference is concerned.

About 12 rockets a year are being employed just to perform this study. NASA now has Memoranda of Understanding for cooperation with Norway, India, and Japan, among others already assisting in the effort to employ sounders from various latitudes around the globe.

Also, NASA is developing cheaper payloads to further broaden international cooperation.

One recent design, for use with a *Nike-Apache*-class rocket, will be made available to all who request it. The experimental package employes two transmitters—one operated at 24 mc, the other at 72 mc. The lower frequency is affected more by the ionosphere, thus characteristics can be determined by differences between the two simultaneous transmissions.

• **Bios II**—NASA is expected to award contracts in the near future on a new animal satellite program. Although budget figures have not been worked out, they probably will be just under $50 million for the next three to four years. FL '63 budget provided $3.6 million, FY '62 $2.1 million. Other space biology funding was $1.3 million, FY '62; $1.1 million, FY '63 for advanced research.

The program will consist of two types of spacecraft, one of which will orbit for only a few days, the larger to orbit up to two weeks.

A study group at NASA is considering using modified *NERV* capsules left over from the *NERV* and *BIOS I* projects for the first part of the program, launched by *Scout* vehicles. This phase would be followed by launch of three or four larger *BIOS*-type capsules, probably with *Atlas-Agena B's*. These might be launched in early 1964.

• **Future investigations**—Intensive studies of the ionosphere and the Sun will be performed over the next decade with a variety of satellites. Also, the three major observatory series are expected to be used for at least 10 years.

While NASA expects to achieve much during this period from those firmly conceived programs already existing or soon to come into being, scientists already envision several future possible investigations. They hasten to point out that these are now just dreams; yet many will undoubtedly begin before 1970.

One, now just in its embryonic stage, is a radio observatory program. Goddard now has one radio astronomer studying the feasibility of such a satellite effort and it hopes to employ more scientists later.

Initial studies must determine what can best be accomplished with ground observatories. At present, it appears that microwave and the low-frequency ranges might be used to advantage in satellites.

A considerable effort will have to be introduced to study antenna operation in the ionosphere, particularly in the 1-10 mc region. The kinds of antennas capable of providing fine directivity must be determined. NASA may begin with very long wire antennas or possibly a pair which could permit use of interferometric techniques.

Large unfurlable dishes and other arrays will be studied for use on satellites or on the Moon.

First physical experiments may begin during 1965 or 1966, some NASA scientists believe. These probably will first employ *Scout*-launched sounders. They emphasize, however, that to provide meaningful data the first launched systems must provide at least an order-of-magnitude increase antenna directivity—and this improvement would be far from the ultimate desired.

Also, during these early studies, the electromagnetic noise activity and contributions from a variety of space sources will have to be collected and analyzed.

• **Comets, satellites, probes**—Another study suggested by NASA scientists would be centered on comets. To engage in such an effort might entail "building" and launching an artificial comet into outer space.

Along with observing results of such a scheme, probes might be launched, aimed to fly through the head and tail for the collection of gas samples.

Other programs now planned or at least being considered include:

• Use of infrared sensors in future *OAO* space systems for the study of cold space bodies.

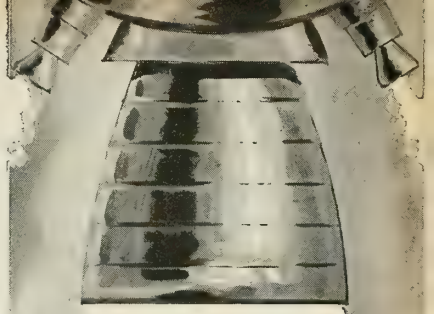
• Solar orbiting satellites, similar to *OSO*, which might assist in future solar activity prediction.

• A variety of solar probes, launched at various angles to the solar system plane and including a solar impact or near-miss probe.

• A variety of near-Earth probes. These probably will await completion of the new *Aerobee-350*. The liquid-fuel booster is designed to carry large diameter (22-in.) optics and payloads between 150 and 500 lbs. It will have a nominal performance of lifting 350 lbs. to 350 miles, NASA claims. ⁂



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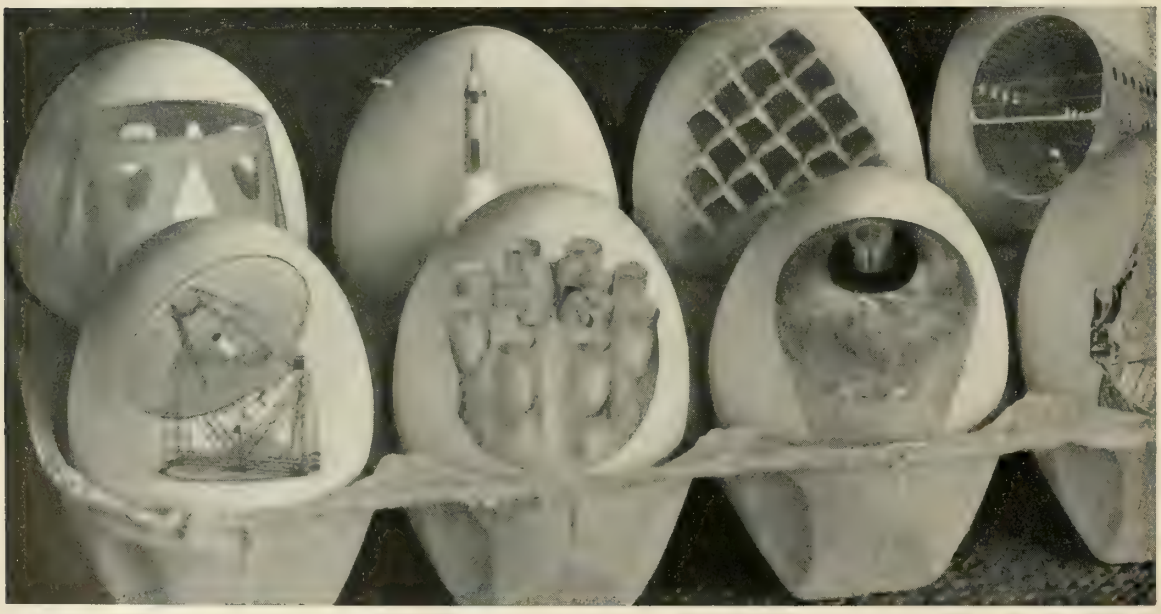
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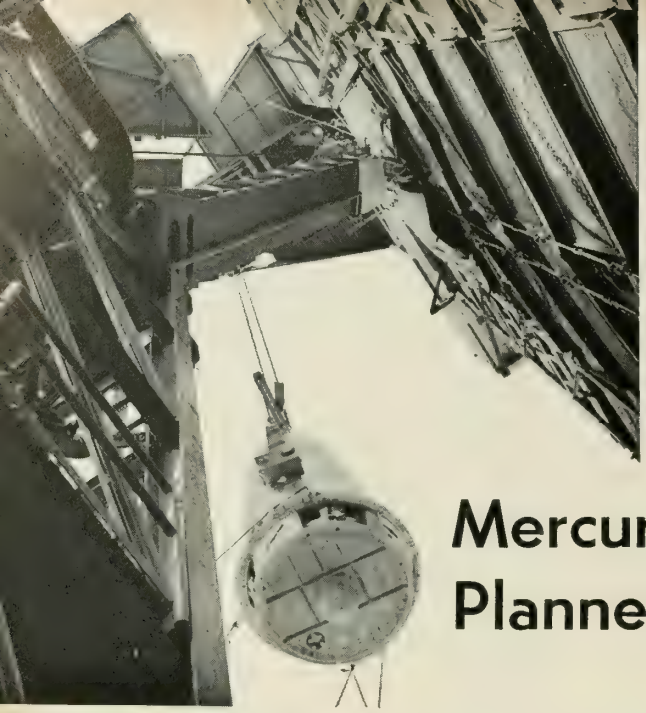
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*AT CAPE CANAVERAL, Ranger spacecraft inside nose cone fairing is hoisted to top of gantry for mating to Agena second stage prior to lunar launch.*

**NASA**/lunar and planetary

# Mercury, Jupiter Probes Planned If Funds Permit

PROBES OF Mercury, Jupiter and comets are expected to be the major future projects in NASA's unmanned lunar and planetary exploration program.

Two solar probes also are being considered by officials at NASA headquarters and the Jet Propulsion Laboratory, which manages the program for the space agency.

The most immediate project is the comet probe scheduled for 1967. The *Mercury* fly-bys would be attempted in 1968-69 with the Jupiter probe in the early 1970's.

Future project scheduling as well as development of current spacecraft programs will depend upon how much of the NASA budget is available for the program after the needs of Project *Apollo* are met.

At present, officials estimate that NASA funding of the unmanned lunar and planetary program will continue to rise over the next three years, reaching a peak in Fiscal 1966.

For Fiscal 1964, program officials are requesting a $100 to $150 million jump over the Fiscal 1963 budget of $232 million.

The Fiscal '64 budget is based on approval of a total agency budget of close to $6 billion. The Kennedy Administration is almost certain to cut it to under $5.5 billion, and further cuts by Congress are possible.

As a result, it is unlikely that an increase of $150 million for the lunar and planetary programs will be approved.

Fiscal '64 funds would cover hardware development of the *Voyager, Mariner B, Ranger, Surveyor* lunar soft-landing and lunar orbiting spacecraft and conceptual study and design of vehicles for the future projects.

If the budget is reduced, officials believe *Voyager* and the future projects will be most affected.

*Voyager* could be delayed for a year—putting off the first mission to Mars and Venus until 1968. The same sort of slippage would apply to the others.

Some budget trimming is already in evidence for Fiscal '63. The original budget request was $259 million, but this has now been trimmed to $232 million. In addition, another $20 million will be reprogramed to help pay for a portion of the five additional spacecraft for the fourth phase of the *Ranger* program. The reductions have also forced a delay in the *Surveyor* lunar orbiting spacecraft.

• **Most lucrative**—In the coming months, highly active programs at JPL for missile/space contractors will include the third and fourth phases of the *Ranger* program (about $60 million), *Mariner B* ($73.7 million) and the *Surveyor* lunar soft landing ($97 million).

Even more promising as sources of business are improvement and expansion of the Space Flight Operations Center at Jet Propulsion Laboratory and the JPL-supervised Deep Space Instrumentation Facility.

Missions for the five additional *Rangers* (10 through 14) in the fourth phase of the program have not yet been selected. Collection of information for designers and planners in the Manned Lunar Landing Program has been assigned highest priority in the unmanned lunar programs, and undoubtedly will be the strongest factor in picking the new missions. Multicamera television packages, like those to be launched next year in the third phase of the program, and hard-landed instrument capsules are both under consideration.

If *Rangers* are launched at the present four-per-year schedule, fourth-phase missions will continue until the spring of 1965, overlapping *Surveyor* schedules. There is some discussion of a fifth *Ranger* phase which might increase the total number of *Ranger* vehicles to 20.

• **Centaur complications**—The unmanned lunar and planetary exploration programs have had to be revised in many ways because of persistent schedule slippage in development of the *Atlas-Centaur* launch vehicle, which is supposed to lift the *Surveyor* lunar soft-landing spacecraft and the *Mariner B* advanced planetary spacecraft.

It is hoped that the last batch of *Rangers* will at least partially fill the *Apollo* design data gap which has opened up as *Surveyor* flight schedules have been pushed back by the *Centaur* delays. Flight of the first of the seven *Surveyors* ordered is now scheduled for the middle of 1964, but NASA officials are pessimistic about the likelihood of *Centaur* being ready by then. Original schedules called for *Centaur* operations in the summer of 1963.

Successive generations of lunar and planetary spacecraft will appear for each generation of launch vehicles. Thus, *Ranger* and *Mariner R* were developed to use the capabilities offered by the *Atlas-Agena* combination, *Sur-*

*veyor* and *Mariner B* will be contemporary users of *Atlas-Centaur*, and *Voyager* is intended to be launched by *Saturn*-series boosters.

• **Tried and true**—Design of unmanned lunar and planetary spacecraft is governed by a rule that subsystems and components which have proven successful on earlier missions shall be used on more advanced missions when possible.

The intention is to evolve a family of spacecraft in which each member will benefit to the maximum from the engineering, testing and flight experience accumulated on its predecessors. Thus, when *Mariner A* was delayed by the *Centaur* troubles, it was possible to adapt the lighter *Ranger* spacecraft to the Venus mission and rename it *Mariner R*.

• **Two-launch policy**—Venus and Mars missions are to be launched in pairs at every planetary opportunity. Since opportunities for Mars are two years apart and Venus opportunities 19 months apart, funding and detailed preparation for each series of two launches does not begin until after the flight of its predecessors.

The policy of launching two spacecraft at every opportunity is intended to improve the likelihood of getting at least one successful mission. Timing of the launches in each pair is slightly staggered to get data over a longer time span if both flights are successful. Two Venus flights to be launched in the early spring of 1964 will be made by *Mariner R* spacecraft similar to *Mariner R-2*, now nearing the end of its mission. *Mariner R-3* and *R-4* will not be fully designed until the results of the *R-2* mission have been analyzed.

*Mariner B* spacecraft will be used for all Venus and Mars explorations after the middle of 1964 if *Atlas-Centaur* booster vehicles are available to lift the heavier spacecraft. The first mission for *Mariner B* should be the Mars flight in 1964. JPL has not received the go-ahead from NASA to proceed with the design of the vehicles for this program, but it is expected very soon.

Advanced *Mariner*-family spacecraft will carry the first landing capsules to Venus and Mars, according to present plans. Mission profiles are being studied by NASA and JPL for the fly-by spacecraft which would eject entry capsules to land on the surface of the planets.

• **Inhospitable Venus**—Entry of the Venus atmosphere is expected to pose a tough design problem. Entry velocity is even greater than for the *Apollo* Earth return, the most difficult entry problem yet tackled by designers.

It also appears that the Venus atmosphere is hotter and more dense than the Earth atmosphere and its chemical constituents may be destructive, but prefly-by information of this nature about Venus is speculative.

JPL scientists suspect it may be worthwhile for the Venus entry capsule to use a retrorocket to dissipate part of the entry velocity. It would undoubtedly be heavy relative to the payload, but the ablative heat shield and structure needed to protect against aerodynamic heating in a pure drag deceleration entry would also be very heavy. The Mars atmospheric entry will be much easier since its atmosphere is less dense than Earth's.

• **Plans for Voyager**—An intensive study to map out the planetary exploration program beyond *Mariner B* has been going on for some months. Results will not be known for at least five months more.

Scientists at the NASA Office of Space Sciences and JPL are establishing planetary mission priorities and setting design requirement for the *Voyager* spacecraft series. *Voyagers*, launched by *Saturn* boosters, would be intended to orbit the planets and telemeter data over a long period.

Scientific experiments on *Voyagers* will be more sophisticated and complete versions of those in the *Mariner* series. Orbit elements of the spacecraft will be analyzed to estimate the mass distribution of the planet. Some versions will carry larger and more advanced landing capsules than those of the *Mariner*

| PROGRAM | MISSION | NO. | ORBIT | WEIGHT | LAUNCH VEHICLE | LAUNCH DATE | LAUNCH SITE |
|---|---|---|---|---|---|---|---|
| RANGER (6-9) | High-resolution pictures of lunar surface. | 3 | Lunar impact | 727 lbs. | Atlas-Agena | 1963 | AMR |
| (10-14) | High-resolution pictures of lunar surface. | 5 | Lunar impact | 727 | Atlas-Agena | (1965) | AMR |
| (15-20) (study) | X | 6 | Lunar impact | 727 | Atlas-Agena | (1965-66) | AMR |
| SURVEYOR | Soft-land 30-day-life payload for lunar measurement. Support Project Apollo. | 7 | Lunar soft landing. | 2100 | Atlas-Agena | 1965-1967 | AMR |
| SURVEYOR | Space platform for reconnaissance study lunar radiation and environment. | 5 | Lunar orbit | 2100 | Atlas-Centaur | 1966-1967 | AMR |
| SURVEYOR (under study) | Not determined. | X | Hover over lunar surface. | X | Atlas-Centaur | Late 1960's | AMR |
| MARINER R | Study Venus atmosphere and surface environment. | 2 | Venus flyby. | 460 | Atlas-Agena | 1965 | AMR |
| MARINER B | Heavyweight spacecraft for Mars and Venus missions. | 6 | Venus and Mars flying. | 1000 to 1300 | Atlas-Agena | 1967 | AMR |
| VOYAGER | Advanced planetary exploration. | X | Orbit Mars and Venus and eject landing capsule. | X | Saturn | 1966-1970 | AMR |
| MERCURY PROBE | Planet study. | X | X | X | Advanced Saturn | 1968-1970 | AMR |
| COMET PROBE | Ranger, Mariner type spacecraft to study an unselected comet. | X | X | X | X | 1967 | AMR |
| JUPITER PROBE | Planet study. | X | X | X | Advanced Saturn | Early 1970's | AMR |
| SOLAR PROBE | Launch out of plane of the ecliptic to study the Sun for latitude efforts. | X | X | X | Advanced Saturn | 1970's | AMR |
| SOLAR PROBE | Orbit Sun at very low altitude. | X | X | X | | 1970's | AMR |
| X | Undetermined. | | | | | | |



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series fly-by spacecraft. These will be used to collect detailed information about the atmosphere and surface.

*Saturn C-1* and *C-1B* launch vehicles with an as yet unspecified third stage are being evaluated for the orbiter-and-landing capsule concept. If *Saturn C-5* boosters can be made available to the program, it would be possible to send payloads of 50,000 to 60,000 lbs., compared to 3000 lbs. for a *C-1* booster.

Availability of *Saturn* boosters for the *Voyager* program will depend heavily on the schedules and booster requirements of the Manned Lunar Landing Program. *Voyager* should be ready for missions some time between early 1966 and late 1968, depending on the launch vehicle selected.

To insure high priority support to the *Apollo* program, there is direct and informal contact between the NASA Office of Manned Space Flight and the Office of Space Sciences in Washington, and between JPL and the Manned Spacecraft Center on the technical level.

• **Surveyor waits funds**—The design of the *Surveyor* lander has been frozen and a *Surveyor* orbiter has been authorized. However, the status of the orbiter is uncertain. The money originally set aside for it in long-range plans has been soaked up by the *Ranger* fourth phase and efforts to solve the *Centaur* problem. Whether new money will be allocated remains to be seen.

The program is being squeezed between the *Centaur* schedule slippages and compressed *Apollo* schedules made possible by the adoption of the Lunar Orbit Rendezvous mission.

Detailed design of a *Surveyor* orbiter spacecraft will not be attempted until it becomes more certain that the program has a future. Following the well-established JPL practice, advanced planners had expected to seek maximum carry-over of engineering from the soft lander to the orbiter. However, due to present uncertainty about the program, officials are unwilling to attempt even a general description of the spacecraft.

The information which *Surveyor* can yield will be somewhat less than expected because *Centaur* performance limitations will restrict the total weight of the spacecraft to 2100 instead of 2500 lbs., as had been planned. The weight of experiment packages has been cut from 150 to 114 lbs. (Reduction of the size of the solid-propellant main retrorocket accounts for most of the weight that had to be taken out of the spacecraft.)

A prototype of the vehicle is to be used in system tests now beginning at the Hughes plant in Culver City, Calif. Later, the prototype will be taken to the JPL Deep Space Instrumentation Facil-


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ity station at Goldstone, Calif., to evaluate its response to actual command signals from a DSIF transmitter. The vernier engines of the prototype will be test-fired at Holloman AFB, N.M., to determine how their vibration affects on-board systems.

Minimum operating life specified for on-board systems is 30 days, and NASA hopes 90 days may be achieved. An array of solar cells will supply power on initial flights but will be replaced by a radioisotope thermoelectric generator when JPL is satisfied that certain operating problems have been solved. For communications, *Surveyor* will carry two 10-watt transmitters, two 100-milliwatt transmitters and two receivers. The duplication is intended to assure reliability.

An unexpected benefit of the *Centaur* delays is the more comprehensive *Surveyor* spacecraft test program which it has made possible.

Lunar program officials express a wistful interest in *Titan III* as a booster for *Surveyor* to replace *Centaur*. However, no serious move is being made to get the change authorized. As Dr. Clifford I. Cummings, JPL Lunar Program director explained, *"Centaur* is only two years away—*Centaur* is always two years away—but no one is brave enough to promise us *Titan III* in that time."

• **Other probes**—The JPL planetary program staff is studying *Mercury* and *Jupiter* probes for the time when *C-5* boosters become available. The engineers point out that electric-propelled spacecraft have obvious advantages for flights such as that to Jupiter and elsewhere outside the orbit of Mars.

Solar power is inadequate beyond that distance from the Sun; nuclear power must be carried for on-board systems anyway, and its use to drive an electric propulsion would shorten the duration of the flight. Suitable electric propulsion systems are not anticipated before 1970.

Three other interesting programs that are a firm part of JPL planning are a comet probe, a probe to be launched out of the plane of the ecliptic (near which all planet orbits are clustered) to study the Sun for latitude effects, and a probe to orbit the Sun at an altitude which may be as low as 0.1 Astronomical Unit (the nominal distance between Sun and Earth) to make a direct study of the solar corona.

The comet probe is regarded as the easiest technically, since comets ordinarily penetrate the plane of the ecliptic at a distance from the Sun somewhere between the orbit of Venus and that of Mars, that is, closer to the orbit of Earth than either of those planets.

Fifteen comets are being studied as potential targets. Because of the very high energy required to place a probe




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in an orbit around the Sun with its plane parallel to that of the comet, the probe will be launched to intercept the target comet on a crossing course. Crossing velocity will be very high at the intercept; comets are very large, however, so instrumentation aboard the probe should have time to take a useful look at the target.

The probe will be launched in 1967 when comet passages will be frequent. The spacecraft could be a member of the *Ranger-Mariner* design family, though boosters capable of lifting a larger spacecraft should be available. Astrophysicists and cosmologists are intensely interested in the composition of comets which apparently have very little mass.

The out-of-ecliptic shot is to get information about the Sun which cannot be obtained from the Earth, Moon, planets, or vehicles orbiting any of those bodies. Their trajectories are all very nearly in the same plane and present the same view of the Sun. It is possible that quite different features would be visible from a point far enough above or below the ecliptic.

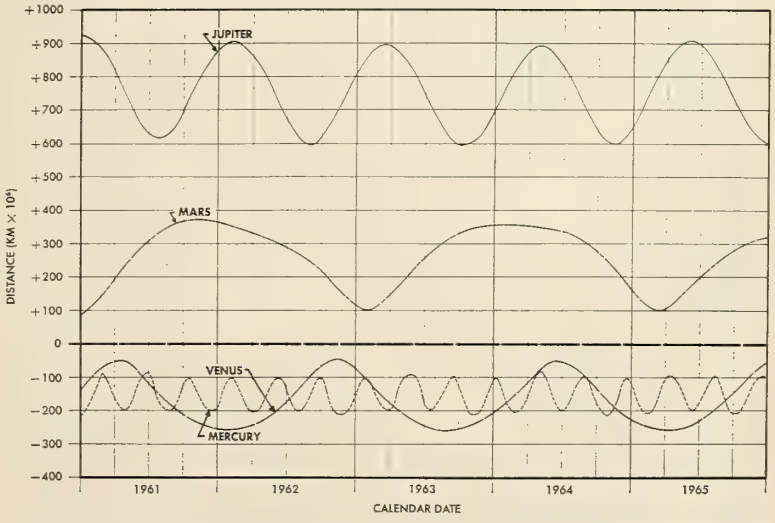
JPL and NASA scientists definitely intend to conduct the experiment if funding can be obtained, but the when and the how of the matter have not been decided. It is certain that the flight will have to await the advent of the advanced *Saturn* family of boosters because of the large energy requirement to tip the orbit of the probe at a large enough angle to the ecliptic to achieve the mission.

A 15° angle to the ecliptic has been discussed and would yield a significant amount of data. The energy required to do the job would approach that required to reach Jupiter. Existing boosters could just about do it with no payload.

• **Practical problems**—A number of operational difficulties plague the out-of-ecliptic shot and may result in a considerable delay. For one thing, the launch azimuth must be inside a narrow sector within 27 degrees East of due North or due South. Therefore, the vehicles cannot be launched from Cape Canaveral without overflying populated areas. It can be launched into the southerly sector from the Pacific Missile Range facility at Pt. Arguello, Calif., but NASA has not expressed any intention of building a *Saturn* launch complex there.

Another operational problem is created by the antenna mounts of the JPL-operated Deep Space Instrumentation Facility, which are designed so that they cannot point very far out of the ecliptic. Unlike Azimuth-Elevation mounts used in conventional radars with one axis of rotation parallel to the local vertical and one axis horizontal, the Hour Angle Declination (HADEC) mounts of the 85-ft. DSIF dishes have one axis of rotation parallel to the Earth's axis and one axis aligned with the plane of the equator. There is one 85-ft. dish with an Az-El mount at the Goldstone DSIF station, but it does not have one of the powerful DSIF receivers.

Plans are under way to construct 210-ft. antennas with Az-El mounts at all three DSIF stations. The first should be operating by 1965 and the other two




*CURVES SHOWING distances of four planets from Earth (represented by zero lines) indicate launch opportunities through 1965. To get maximum payload for a given booster system, launch must be timed so intercept will occur when planet is closest to Earth. Minus figures on the vertical axis indicate distance inside orbit of Earth. Plus figures show distance to orbits farther from Sun.*

# CONTROLS SYSTEMS ENGINEERS for LOS ALAMOS SCIENTIFIC LABORATORY

Los Alamos is expanding its Project Rover test facilities and has established a permanent organization at the Nuclear Rocket Development Center near Las Vegas, Nevada. Career opportunities exist in connection with development of very high power, fast start-up reactors.

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Employees live in or near Las Vegas, and are permanently assigned to work at the Nuclear Rocket Development Center. Project Rover is operated by the Laboratory for the U. S. Atomic Energy Commission. Send resume to:

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should be ready by 1967. Adequate boosters for the out-of-ecliptic flight will be available before then.

• **Close look at Sun**—One of the most ambitious programs in advanced planning at JPL is the direct investigation of the solar corona by a probe orbiting the Sun at low altitude. Distance between the probe and the Sun has not been decided because there is a division of opinion about how far measurable corona effects extend into space. *Mariner R-2* may yield some information about this after it passes Venus. A likely altitude would be 0.1 Astronomical Unit (A.U.).

Energy required to place a vehicle in such an orbit is even more than is required for the out-of-ecliptic shot. Operational problems are much less severe but the on-board transmitter would have to be unusually powerful so that its signals can be detected above the level of solar noise as the probe crosses the face of the Sun.

The Earth orbits the Sun at a velocity of 19 miles per second, which is characteristic of any solar orbit at a distance of 1.0 A.U. When an interplanetary vehicle has achieved Earth-escape velocity and been injected into the same orbit as this planet, a velocity increment or decrement is needed to propel the spacecraft into a new orbit with a different velocity which will take it to its destination.

• **Toward better Center**—JPL technologists are controlling the flights of *Ranger* and *Mariner* vehicles from a prototype Space Flight Operations Center and in the process are accumulating information for the design of a permanent SFOC able to handle the more complex and more frequent space flights of the future efficiently.

• **Tracking**—The DSIF Operations Manager has a console at the left of the Test Director and coordinates the use of the three great tracking and telemetry stations at Goldstone, Calif., Johannesburg, Union of South Africa, and Woomera, Australia. The DSIF sends data to the SFOC by teletype and the data is transferred to IBM punch cards, the computers process it, and experts in the SFOC devise maneuver commands, trouble shooting and corrective procedures.

DSIF scientists forecast a billionfold increase in the telemetry capacity of their stations in the eight-year period that began in 1961. Important advances are attributed to the 210-ft. antennas which will begin to operate in 1965; the shift from L-band (960 mc.) to S-band (2295 mc.); replacement of present 4-ft.-dia. spacecraft antennas with 9-ft. antennas on *Mariner B*, *Voyagers*, and other spacecraft; increase in spacecraft transmitted power from 3 watts to 25 watts and then to 100 watts; and adoption of a Traveling Wave Maser amplifier to replace the present Cavity Maser. The Traveling Wave Maser is now being tested and will make possible much lower receiver noise levels.

Among the things that DSIF officials hope to obtain from industry are:

—A light, reliable r.f. power amplifier that is 50% to 75% efficient at a usable frequency and has phase-stable, spectrally pure 100-watt output.

—A light, ultra-stable time reference oscillator with an accuracy of 1 part in $10^{13}$. Present atomic standards are capable of 1 part in $10^{10}$ for short periods or 5 parts in $10^{10}$ for long periods (approximately 15 min.).

—Erectable or inflatable large spacecraft antennas.

It is possible that the DSIF will act as part of the Project *Apollo* Ground Operations Support Systems (GOSS) network. DSIF officials would be happy to take part in the operation, and some think it is very likely that NASA will decide to take advantage of the large existing capability that the DSIF net possesses.

• **Farming out**—The sharply rising trend in the volume of lunar and planetary program work being passed on to industry by JPL rather than being done in the lab can be attributed to three important factors:

—Many unmanned space programs have reached, or are approaching, fruition; the volume of component and subsystem development, testing, and manufacturing is exceeding the capacity of the laboratory.

—As progressively larger launch vehicles become available to the unmanned programs, it becomes possible to design larger and more complex spacecraft. This is compelling JPL to delegate ever larger responsibilities to industry and to bring contractors into the program earlier in the development cycle.

—According to a candid JPL official, the lab no longer sees itself as a competitor of industry, but as an agent of government charged with the responsibility of mobilizing industrial teams and conducting operations in space. Consistent with this attitude, the laboratory now seeks to turn a job over to industry as soon as the task is well defined by JPL technical divisions.

JPL officials believe that first-rate competence can be maintained only by keeping a strong basic research program, at least one advanced development program, and at least one scheduled flight program in the lab at all times. They contend that they can succeed in their program management job only if they can remain one technologi-

cal jump ahead of industry.

In the hope of assuring a large pool of technically up-to-date potential contractors, JPL conducts a sizable printing operation to feed new technical information from the lab's divisions to industry.

The organization of the laboratory is designed to be stable and flexible under the stresses of growth and the complications of managing a number of systems at once. No need to reorganize or alter the pattern of doing business is foreseen.

The basic capabilities of the laboratory are in the technical divisions. The small, special program offices draw on these when a need for talent arises. Men who are not needed for one program are available for others. If the workload gets too heavy for the technical divisions part of it is contracted out to industry or other institutions.

Under this arrangement, technical division personnel are ordinarily the ones who make the first move in the contracting process. This is not the case if a system management prime contract —such as the Hughes contract for *Surveyor*—is to be awarded. The initiative on these comes from the program office.

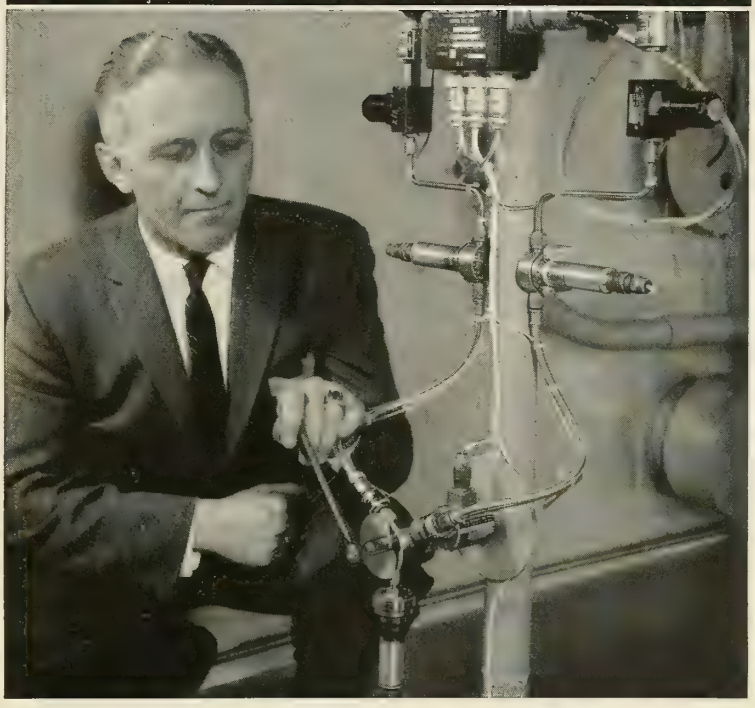
• **Supplier file**—The JPL Procurement Services Office keeps a file of about 1500 suppliers in all categories and sizes. Companies that want to be listed must query the office, because there is no active program to seek out new additions to the file. The laboratory then sends an elaborate form on which to list company capabilities.

Would-be bidders also receive a list of 252 "areas of special interest" in which the laboratory has continuing frequent requirements. Most of them are electronic components and subsystems.

The philosophy of the Procurement Services Office is to act as a contact point for companies and the JPL technical divisions and not to operate as a filter against unsuitable bidders. On some procurement, only three people are involved, the technical man, the vendor's sales engineer, and the procurement officer.

Ordinarily, the technical division representative and the procurement man draw up a Statement of Work and request bids from companies listed in the file as capable of the job. Companies sometimes submit bids with suggested changes in the Statement of Work. One-shot procurement results in the longest and most complex Statements of Work because of the impossibility of referring to existing specifications. When the value of an order is to be more than $1 million, a Source Evaluation Board is set up with high-ranking technical and procurement officials as its members. ⌘


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# Appropriation Cut Almost in Half

## *Rising costs of other programs, congressional action, changes in ComSat requirements result in reduced funding*

NASA's Fiscal Year 1963 appropriations for communications satellites will be about half of its original request.

Actual funds for development of communication satellites and associated technology in the FY '63 budget will be $48 million. This represents rebudgeting of almost 50% in the $85,377,000 sought.

Rising costs of other space agency programs, some congressional cuts in portions of the overall NASA request, and changes in ComSat requirements since the first request was submitted are said to be the major reasons for the trimming.

Though the approximate level of FY '63 ComSat funding is known, it is still not certain how individual program budgets will be juggled. NASA is working at this now, and officials say firm budget plans should be available before the end of the year. However, it is known that the space agency's passive ComSat Project *Rebound* will be deferred, at least temporarily, and that other programs—including *Relay, Intermediate Altitude Communications Satellite,* and the high-altitude (22,300 miles) *Radiation Measurement Satellite* program—also will suffer cutbacks.

• **Decisions looming**—Calendar '63 will be a crucial year for NASA's ComSat programs, particularly the active-repeater projects. Performance of the first experimental NASA-RCA *Relay* satellite, which the space administration is pressing to get off the ground before this year ends, and the NASA-Hughes *Syncom* satellite, expected to be launched in the first quarter of calendar '63, will both weigh heavily in the future course of active-repeater development.

There is strong pressure to move ahead quickly with programs such as *Advanced Syncom* and the *Intermediate Altitude* system (sometimes incorrectly labeled *Advanced Relay*), but the decisive influences will be the success or failure of the early *Relay* and *Syncom* flights, plus the recommendations flowing out of a handful of key NASA in-house and industry studies of critical problem areas.



*FULL-SCALE MODEL of advanced Syncom satellite built by Hughes Aircraft Co. The satellite will be five feet in diameter and weigh 500 lbs.*

There are various long-range projections of where the ComSat program will go and how heavily it will be funded, and conflicting opinions as to what type of system looks best for commercial operations. However, the hard decisions will come only after these early flights and also—perhaps equally important—after the newly formed ComSat Corp. (M/R, Sept. 3, p. 17) gets down to business. NASA will remain heavily in the ComSat R&D business, in any case, but how big a role ComSat Corp. takes—and how quickly—will certainly affect what the space agency will have to do to sustain the U.S. effort in this field.

Best guess by NASA on an operational date for a commercial ComSat system is about 1967. This will probably be an active system, and may also wind up at a low or medium altitude due to considerable controversy—international in scope—concerning the inherent time-delay problems which are involved with the use of a synchronous altitude (22,300-mile) system.

For FY '64, a top space agency official estimates that the NASA request for communication satellite funds will be at about the same level as this year. Projections beyond FY '64 cannot yet be made with any accuracy. This will no doubt include some of the defrayed FY '63 costs.

Early 1963 also includes launching of the *Echo A-12* rigidized sphere passive ComSat, the next and probably last *Echo* shoot. An Applications Vertical Test (AVT), No. 3 in the series, was also slated for the second quarter of '63 to check out additional materials and inflation control systems; however, in view of the passive program deemphasis, these plans may be altered.

• **Other areas**—In addition to identifiable active and passive ComSat projects and the radiation measurements program, NASA is carrying on a multimillion-dollar advanced research and technical development program. These studies in many cases directly feed existing space programs, but they are primarily aimed at furthering NASA's role as an R&D agency and advancing the state of the art in many technologies upon which ComSat design is based.

Of the $85.4 million requested by NASA for the ComSat program, slightly more than $5 million was about evenly divided between advanced research and advanced technical development. Though some of these studies may now be reduced or postponed for lack of fiscal support, the request for monies in these areas gives industry a major clue as to the space agency's future needs.

—*Advanced Research* includes: technical and operational studies, nuclear power supply studies, optimizing antenna arrays for ComSats, high-gain reflective structures, modulation and demodulation techniques, simulation of ComSat systems, quasi-passive techniques, materials and components, and K-band RF power sources.

—*Advanced Technical Development* includes: development fabrication and testing of high-gain reflective structures, long-life traveling wave tubes, and advanced attitude stabilization techniques.

NASA's communication satellite programs are directed from the headquarters office of Leonard Jaffe, direc-



*HUGHES TECHNICIANS fit hydrogen peroxide jet control system of Syncom satellite into place. This satellite is 28 in. dia., 25 in. long and has a payload weight of approximately 75 lbs.*

tor of communications systems. Actual implementation of the programs is the responsibility of the Goddard Space Flight Center ComSat group headed by Robert Mackey.

NASA ComSat programs currently include two existing active-repeater programs—*Relay* and *Syncom;* two new and more advanced active projects for which funding was requested for the first time in the FY '63 budget—the *Intermediate Altitude Satellite* and *Advanced Syncom* (neither of which has yet been approved as a flight program); and two passive programs—Project *Echo* and Project *Rebound,* the latter now in an advanced research status and not yet approved as a flight program.

Here is how these programs stand today:

• **Project Relay**—First of NASA's active real-time repeater communication satellites will be the RCA-built *Relay.* Launching of this spacecraft is still slated for later this year.

*Relay's* size, weight, orbital characteristics, spin stabilization and magnetic torquing system, and channel capacity are all roughly similar to the AT&T *Telstar.* In the light of *Telstar's* remarkable performance to date, *Relay,* in some circles, is on the spot to perform as well. However, there are many salient differences between the two payloads and successful orbiting of *Relay* is certain to expand the ComSat technical base.

*Relay's* wide-band transmitters include RCA-designed traveling-wave-tubes with a 10-watt output, roughly four times as powerful as those in *Telstar.* The tubes use a new cathode design and a lightweight platinum cobalt magnet.

*Relay's* transmit/receive frequencies of 4170 mc and 1725 mc will also provide new operational comparisons with those of *Telstar.* Launching of *Syncom* early next year will add still two more frequencies and will give the space agency a broad base with which to study the relative merits of any particular frequency range. Frequencies between 1 and 10 kmc are generally considered optimum for communication satellites.

In addition to transponder design differences, the *Relay* antenna design is also different from *Telstar,* using a lightweight common mast arrangement to mount the transmit/receive antennas. The antenna is circularly polarized and emits a constant omnidirectional signal.

*Relay* will also carry an advanced scientific package to gain additional data on radiation damage to at least two types of solar cells with varying degrees of shielding, and also on proton and electron activity levels at ComSat altitude.

Perhaps the most significant design difference between these two active repeaters is the virtually complete redundancy built into *Relay.* This design approach is a source of controversy among some of the leading designers in this field. To insure reliability and get the one-year expected lifetime, every essential subassembly, involving some 3000 components, will be duplicated.

*Relay* will be placed in an elliptical orbit from AMR, inclined about 50 degrees, by a *Thora-Delta* vehicle. Satellite shape was chosen to make maximum use of the *Delta's* protective shroud.

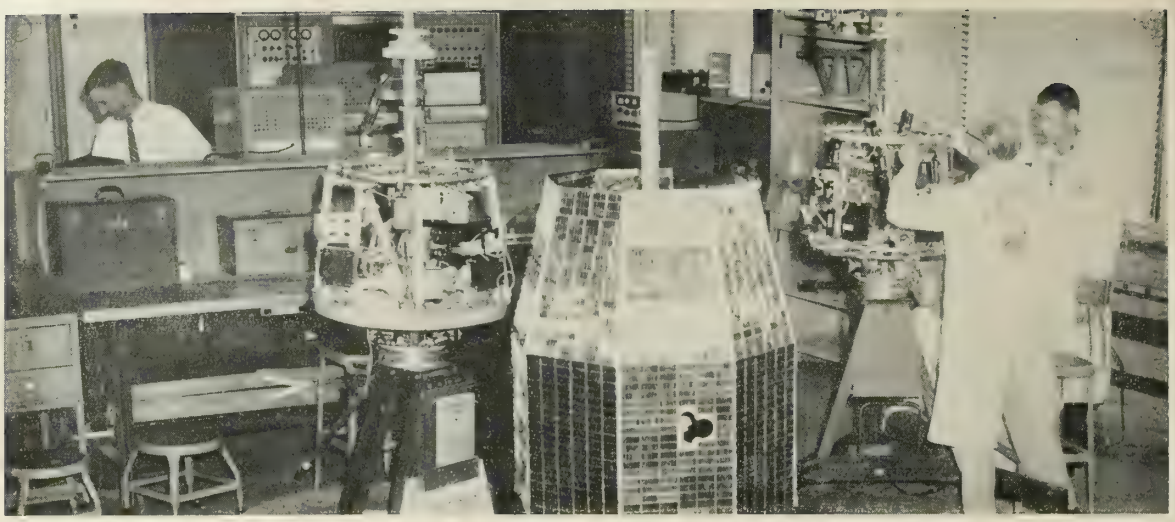
All major funding on *Relay* has been awarded. A second flight is planned for mid-1963, with possibly a back-up launch for either of the first two. However, two more satellites of "an improved design," not *Advanced Relay,* which were originally on the NASA flight schedule for 1963, "might suffer" from the rebudgeting, according to a NASA official. This is probably due to cuts in the number of *Delta* boosters requested.

NASA requested $19.1 million for *Relay* in FY '63.

• **Intermediate Altitude Communications Satellite**—This program is one of the two major new undertakings NASA included in its request for FY '63 funds. More than $21.5 million was requested, but development is certain to be delayed (M/R, Oct. 1, p. 9), possibly due in part to some slippage in the *Relay I* launching. Exactly how much the program will actually be funded is one of the questions now being mulled over within NASA headquarters. No hardware contracts on this project are expected in FY '63.

As of now, neither this program nor the *Advanced Syncom* exists as an approved flight program. In fact, the *Intermediate Altitude Satellite* does not exist at this point—in terms of an advanced study phase.

According to Director Jaffe, a firm



*RELAY COMMUNICATION satellites take shape at RCA's Astro-Electronics Div. They're being built for NASA's Goddard Space Flight Center. Foreground shows solar panel arrangement fitted to a bare structure before being fastened on Relay.*

decision on this program is not likely until the end of the first quarter of next year. He points out that this decision cannot be made before initial experience with *Relay* and *Syncom*.

Until then, NASA will conduct an intensive in-house effort combined with some outside study contracts of a more general nature to identify as many of this satellite's critical components as possible. Studies will also be directed at the number of satellites that would be needed in a system of this sort, the requirement for attitude control, stabilization, orientation, power, and power supplies. Also getting heavy attention will be development of design techniques for multiple-access capability for ground stations.

"As we define individual pieces of this," Jaffe says, "we will probably establish a development effort." He doubts that a flight program will be approved before these individual elements are in being.

Though some general study contracts have already gone to STL and Rand Corp., Jaffe says a system design study is not likely until "we can pin down these components."

NASA scientists at Goddard SFC were hopeful that a specific spacecraft feasibility study contract might be let by the space agency soon after the first of the year, indicating some progress on component development.

According to NASA, development of an *Intermediate Altitude Communications Satellite* is a logical extension of the low-altitude *Relay*, yet it is not officially referred to as an *Advanced Relay*. This is probably because the intermediate-altitude vehicle is actually a brand new program aimed to function at a new altitude, and may have to develop considerably new and different hardware and techniques from that of its lower-altitude predecessor.

This could mean that more contractors not now in the ComSat program may have a better opportunity here than they would have on a program such as *Advanced Syncom*, which should draw heavily upon those firms already involved with *Syncom I*.

An intermediate-altitude satellite operating at between 6000 and 10,000 miles, would, in effect, be a compromise between the lower-altitude *Telstar* and *Relay*, and the synchronous-altitude *Syncom*. These intermediate altitudes will still provide long mutual visibility time between widely separated ground stations—without requiring either the large number of satellites or extensive ground station requirements implicit in a low-altitude system or the heavy booster and sophisticated stabilization requirements of the 24-hr. orbital systems.

As currently envisioned by NASA, this system would ultimately provide the same channel capacity as an *Advanced Syncom*, employing four transponders each capable of handling an estimated 300 two-way telephony channels or a single TV channel. The system will probably use a gravity-gradient type stabilization system.

In discussing the intermediate-altitude program, Jaffe points out that though no system study has been awarded to date, as has been the case with *Advanced Syncom*, this does not necessarily indicate a more advanced development stage for *Syncom*. He points out that the intermediate altitude system may actually require less development work and have fewer unknowns and critical elements than the wide-band synchronous altitude satellite at this point. In particular, he notes the additional study required on the *Advanced Syncom* apogee motor and phased-array antenna.

Jaffe hits at three major areas of development which NASA will concentrate on which should have across-the-board application in many upcoming projects:

1) *Stabilization*—Spin stabilization, gravitational and magnetic field interaction methods will get continued study in addition to development of long-life multiple-axis control systems. Gas jet systems will continue in use and will be refined, however supply limitations will also cause additional R&D on electrically driven inertia wheel approaches (M/R, Sept. 17, p. 70). Naturally, with improvements in stable platforms much higher gain antenna configurations will be possible. All decisions must be carefully weighed against a host of power, weight, and complexity trade-offs.

2) *Power Supplies*—NASA is working hard at improving solar cell technology and is also concentrating on development of radioisotope power. A funded program in this latter area is reportedly being considered. Commenting on the application of *SNAP-8*-type power to ComSats, Jaffe points out that though many talk of this and it will no doubt become technically feasible, the application "is a long way off; not within this decade."

3) *Multiple Access* — Included in the development of techniques allowing efficient multiple access for ComSats are a host of decisions to be made concerning basic transponder types and numbers and also modulation schemes. NASA is not now soliciting contracts in this area, though they are responsive to new but not directly solicited ideas. Results of theoretical studies of various modulation techniques on multiple-

access designs by both the Rand Corp. and the Stanford Research Institute may show the need for more detailed and specific studies.

• **Syncom**—Launching of the first near-synchronous (22,300-mile) communications satellite expected in the first quarter of '63 will give the U.S. first performance data on a system which many feel may in the long run provide the ultimate in commercial ComSat design.

The 125-lb. narrow-band satellite, which includes in its weight a 70 lb. apogee "kick" rocket for synchronous orbit injection, has been developed for NASA by Hughes Aircraft Co. *Syncom I* measures only 28-in. in diameter and will be capable of only a single two-way telephony link. The payload also employs considerable redundancy of major electronics, and the TWT power amplifier will have a 2-watt output.

Much of the ground station equipment used during the *Syncom I* experiments will be that developed by DOD on the now reoriented *Advent* program.

*Syncom* will be launched into an orbit inclined 33 deg. from the equator, and therefore the satellite will not represent a truly synchronous or "stationary" ComSat. It will actually describe an elongated figure-eight pattern every 24 hours, moving 33 degrees north and south of the equator along the same longitude during this period.

With the use of more powerful boosters, advanced satellites of this type can be placed directly into the desired equatorial orbit from AMR.

Despite *Syncom's* limited channel capacity, the satellite should provide the first operational evaluation of time delay and echo problems. Hughes engineers tend to write off the time-delay problem as not very annoying—though many others don't agree—and have also come up with an echo suppressor for use with high-altitude satellites developed by General Telephone & Electronics Corp.

*Syncom,* because of weight limitations, will carry no radiation experiments. Damage from Van Allen belt proton particles at these altitudes is expected to be considerably less than with lower altitude satellites. The *Radiation Measurement Satellite* program eventually will make detailed studies of the levels at the 22,300-mile level. Transmission from the ground will be at 7500 mc, and from the satellite at 1850 mc.

Probably the most important aspect of *Syncom* design, and the one which has sped availability of the satellite along faster than most believed possible, is its uniquely designed attitude-control and antenna-pointing system.

*Syncom* will be spin-stabilized at 165 rpm (using the spin imparted by the booster's third stage), much like other ComSats; but it will also be equipped with hydrogen peroxide and nitrogen jets for coarse and fine attitude control, perhaps controllable to within ±10 fps.

After approximate synchronism at the desired longitude is achieved, the spacecraft will be oriented so that its spin axis is perpendicular to its orbital plane, much like a wheel riding on a track around the earth.

This will be done by pulsing the attitude-control jet, located on one end of the vehicle, by command from the ground, based on information about the vehicle's attitude and spin angle furnished by a solar angle sensor. Any "nodding" of the satellite on its axis will be removed by a mercury vapor nutation damper.

Final, precise adjustments in the spacecraft's synchronism will be made by pulsing the velocity-control jet located on a side panel.

With this orientation, the slotted array antenna, yielding an expected 6 db gain and radiating a figure-of-revolution pattern, can continually encompass the Earth while the satellite is spinning. If this early system succeeds, Hughes claims it will lead the way to achieving with this type of antenna arrangement and spin stabilization the same high antenna gain that could be achieved using far more complicated, fully stabilized inertial platforms.

A second *Syncom* is slated for launching in the second quarter of '63 with a back-up ready after each launching if necessary. The bulk of funding for *Syncom I* came through FY '62 money, with another $4.1 million requested during FY '63. No new awards are anticipated in this program.

• **Advanced Syncom**—NASA's *Advanced Syncom* program will naturally build heavily upon experience gained in *Syncom I,* and will, in effect, be aimed at extending *Syncom I's* extremely narrow-band capability into a wide-band system with an extensive multiple access capability.

The satellite is expected to use similar techniques for achieving and maintaining orbit; however, it should hold a truly synchronous position with respect to the Earth through use of an *Atlas-Agena* booster to put it into equatorial orbit from AMR.

*Advanced Syncom* is expected to weigh about 500 lbs., exclusive of the apogee motor. It will also be spin-stabilized and then rotated perpendicular to the orbital plane, similar to *Syncom I;*




*TEST SATELLITE 12½ ft. in diameter is static inflated before being delivered to NASA for evaluation. Sphere is one of a series built by Geophysics Corp. of America's Viron Div., and is designed to test characteristics of passive communication satellites.*

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but it will carry a more sophisticated, electronically-steerable 16-element phased-array antenna employing ferrite phase shifters. With this, Hughes engineers hope to achieve 18 db of antenna gain.

This antenna reportedly will develop a searchlight beam pattern and will be kept pointed at the earth by "de-spinning" the antenna at a rate equivalent to the rate at which the satellite is spinning forward.

According to C. Gordon Murphy, project manager at Hughes, "when we demonstrate this and show that it works satisfactorily, I believe the arguments over the various types of communication satellites will be finished."

NASA will conduct studies to check on any detracting angle modulation or system degradation effects resulting from this procedure.

The satellite is expected to carry 4 dual-mode 2.5-watt output single-sideband transponders, design of which presents some linearity problems. Other key technical areas in development of this system, according to NASA, involve developing maximum performance of the hot-gas reaction control for attitude control and station keeping, and optimizing a spherical or near-spherical apogee motor.

*Advanced Syncom,* for which NASA requested $18.6 million in FY '63, is still in the study phase of its advanced research program, and not yet an approved flight program.

The $2.3-million study awarded to Hughes in June covers, in addition to spacecraft feasibility design, several of the key or critical elements: the phased-array antenna, control system, and SSB transponder. The results of the study, expected in February or March, should signal a decision on the flight program.

NASA officials at Goddard look for approval of the program at that time and funding beginning in March, '63. Hughes is considered a natural for the airborne portion of the program, but NASA sources point out that there may be a much more wide-open market for some of the ground equipment, especially the SSB and FM gear, than there was with *Syncom I.*

The bulk of the funding on any approved *Advanced Syncom* flight program will probably come in FY '64 and '65, according to NASA, with a drop-off in FY '66.

If approved, NASA reports FY '63 funds will begin spacecraft development and start fabrication of the first two satellites. Early funding of the booster procurement would also come from FY '63 money. Two flights in 1964 and one in '65 are planned.

• **Project Echo**—Sometimes called *Echo II* but more properly known as *Echo A-12* (or rigidized sphere), this passive ComSat balloon is a larger (135-ft.-dia.) and inherently more rigid vehicle than the *Echo I* balloon which is still in orbit.

*A-12* is slated for launching from PMR aboard a *Thor-Agena* booster during the first quarter of calendar '63.

It's hoped that the three-layer aluminum mylar laminate structure, developed for NASA by the G. T. Schjeldahl Co., will show improved radar reflectivity and usable lifetime in orbit. The balloon will be equipped with beacons, to facilitate acquisition and track. The same device will also provide telemetry on skin temperature and inflation pressure.

No other orbital *Echo* launchings are scheduled at this time. No new funding is anticipated, with the possible exception of some small awards for radar cross-section measurements and life data experiments.

• **Project Rebound** — The temporary de-emphasis of passive ComSat programs pending further R&D will be most obvious in its effect on Project *Rebound,* the space agency's program to develop both hardware and techniques for placing a multiple passive ComSat payload into orbit with the use of a single booster.

*Rebound,* according to NASA, has been deferred and will exist only as an advanced research study, at least for this fiscal year, and not as an approved flight program. Whether or not the funding ($16.7 million requested in FY '63) and the flight plans will be revived next year is not yet clear.

Possibly a factor in the rebudgeting in this area was the decision disclosed by NASA that the satellites be put into random orbits rather than the precise orbits originally planned.

The decision to go with random orbits was reportedly based on the conclusions of a Douglas Aircraft Co. study made for NASA. Though both types of orbits could probably be achieved, the random orbit would be considerably easier and less expensive within the current state-of-the-art.

For precise orbital positioning, a fairly accurate attitude control system would be required, in addition to telemetry equipment to facilitate tracking and error correction. Even with this equipment aboard, top NASA scientists believe that with existing technology the precise orbits would soon deteriorate into random ones.

In a *Rebound* flight program, the first of two previously planned PMR launchings could not now be expected to come before late 1964. Original target date was in 1963. The payload will be lofted aboard an *Atlas-Agena* into a


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1700-mile circular orbit inclined at 82 deg.

The first flight, when scheduled, is certain to include a mixed payload (M/R, May 28, p. 18), with some NASA scientists indicating as many as five satellites may ride aboard the single booster. This payload may include three different types of passive spherical satellites, with perhaps two each of two particular structures. There are no present plans to include non-spherical passive structures in the *Rebound* payload.

At the moment, the materials likely to go aboard a *Rebound* payload include the tri-layer aluminized mylar laminate developed by Schjeldahl for *Echo A-12;* another tri-layer Schjeldahl structure which uses a chemical milling process to remove a considerable portion of the satellite's skin in orbit, leaving hexagonal shaped holes in the aluminum layers; and a very thin and lightweight expanded aluminum mesh developed by the Viron Div. of Geophysics Corp. of America, which is laminated between two sheets of polypropylene. The covering is removed by solar heating once in orbit.

Though there are no specific plans in this area, some observers believe the *Rebound* multiple injection technique may provide a good base for similar launchings with active systems.

Air Force, Army, and DOD interest in *Rebound* and the overall passive program is also substantial. There are many observers both in industry and the military who feel that passive ComSat techniques may be very useful to the military for a global wide-band capability with a good deal more security to offer than many active satellite designs.

The big NASA R&D need in the passive program is for improved materials and structural shapes. Material studies will focus primarily on achieving higher reflective gains. Also, new shapes are being studied in conjunction with gravity-gradient stabilization techniques. New contracts are anticipated in the near future in both areas, NASA reports. One official speculated that some of these, in particular those dealing with shapes, may go to universities.

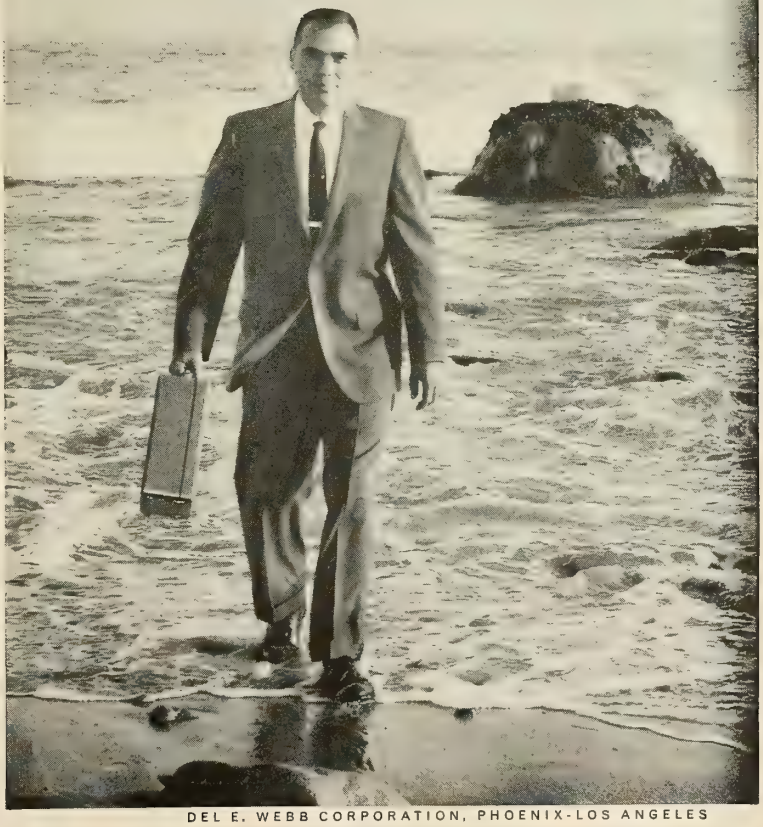
Despite the increase in interest in non-sperical passive or quasi-passive ComSats, NASA officials stress that this is only in an advanced research stage and there are currently no flight programs whatever for these designs. Nor is there likely to be one, according to Jaffe, until the materials problem is well in hand. "We are still looking for a big improvement in materials," says Jaffe. "We must boost too much into orbit at this point to make the passive devices competitive with active satellites." ⌘


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# Agency Shaping Program for Decade

***Further improvements in successful Tiros sought; Nimbus development pressed; Aeros holds promise***

NASA'S METEOROLOGICAL satellite R&D budget may hit any level from $50 million to $100 million a year five years from now, although it is most likely to be about $75 million annually.

FY '63 budget, approved at $64 million, will be reprogramed to fund three newly added *Tiros* satellites. In addition, the Weather Bureau is expected to have a satellite budget of about $50 million a year.

Other new programs under consideration:

—*Development problems of a synchronous satellite*—a concept referred to as *Aeros*.

—*New orbits, experiments and uses for the Tiros satellite.* This may result in orders for seven additional satellites, bringing the total to 15 satellites by the third quarter of 1964.

—*A global operational meteorological satellite system.* The United States and the Soviet Union have been holding bilateral discussions on this possibility since an exchange of notes between President Kennedy and Premier Khrushchev. It remains to be seen how the recent international tensions will affect this effort.

—*The continuing search for more reliable components for Nimbus,* the second-generation satellite slated for first launching in late '63.

—*New ways to use satellites in measuring temperature, water vapor and pressure from afar.*

• **Aeros concept**—A study group at NASA's Goddard Spaceflight Center in Greenbelt, Md., is working full time on the problems of developing a satellite which will permit continuous viewing of all spots on the Earth.

The only possible way to do this seems to be with a 24-hour, 22,000-mi.-high synchronous satellite. However, NASA is not ruling out other approaches, should they be discovered.

Although bids for study contracts were received more than six weeks ago, no contracts were awarded. "They left something to be desired," one official reported.

The in-house study is trying to determine three things about why the response from industry was not what Goddard had hoped:

—How well did we (Goddard) do in outlining what we needed? (In other words, was the request for bids drawn up in such a way that it misled the contractors?)

—How well did industry firms do in drawing up their bids?

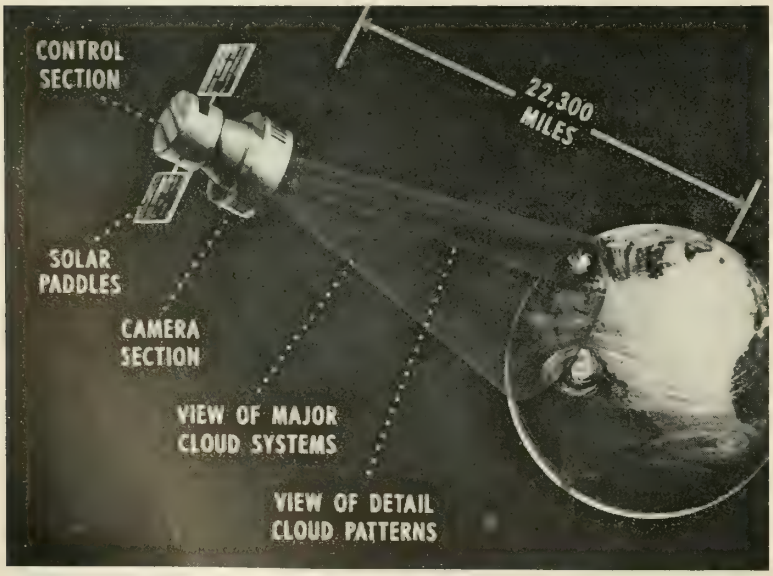
—Or is the only outlook the kind of system indicated in these bids?

The main problem is one of weight —and thus, basically, of boosters. The systems so far proposed would weigh about 1000 lbs., requiring the *Centaur* booster. But reported delays in the *Centaur* program are causing more than one official chagrin.

Meteorological satellite officials said they would favor a smaller spacecraft, with a simple design, if it could be designed. The whole concept will be evaluated in a year's time.

As many study contracts as can be fitted into the budget and are thought worthwhile will be awarded. This may cover several approaches. In addition, some technical information is expected to come out of the *Advent* program.

• **Alternative gear**—NASA also has not outlined the components it wants on the spacecraft. According to top officials, there are a number of alternative




*AEROS SATELLITE CONCEPT: Artist's depiction shows Earth-oriented satellite in 22,000-mi. synchronous orbit over the equator.*

systems that might do the job.

The camera, for instance, could be a two-camber or variable focal system. Requirement is for a system that will provide a choice of viewing the entire Earth at once, or viewing selected spots in detail.

Development time, if all goes well, will probably be about two to two-and-a-half years. This would mean that the first satellite would be launched, if the program is approved, no earlier than 1966.

The first six-month contracts are expected to point up the major problems. The next year and a half will be spent on the lead items, probably the sensors and the problem of station keeping.

Some component research for advanced satellites of the *Aeros* type is now going on at Goddard. This includes studies of sensors, power problems and advanced camera design, as well as a search for ways to see the night side of the Earth.

Some thought also is being given to using a small satellite (such as *Tiros*) to "scout" *Aeros* problems.

• **One a year**—If the system is approved, officials say that NASA probably would launch one satellite a year. The Weather Bureau's Meteorological Satellite Applications has already indicated that it would be interested in funding additional *Aeroses* for operational use if the program proves itself.

If all goes well, probably four or five research and development flights would be made by NASA, with Weather Bureau models sandwiched in between.

The main jobs *Aeros* would do:

—Watch the origin and follow early hurricane developments and typhoons. As these originate in the low latitudes, they cannot be viewed more than once a day each by *Tiros* and *Nimbus* TV and IR.

—View and identify mesosystems which have less than a six-hour lifetime. Some of these systems seem to have identifiable characteristics and have been briefly glimpsed by *Tiros*.

—Possibly identify tornadoes, or at least the small systems which spawn them.

Officials caution, however, that *Aeros* is not yet a program; it must meet priority and resources criteria at the administrative level.

No satellite types beyond *Aeros* are envisioned by Met/Sat officials. *Aeros*, in equatorial, synchronous orbit, would complete the orbital coverage of weather satellites since *Tiros* is in inclined orbit and *Nimbus* will be in polar orbit. However, each type will continue to improve and change.




*FROM ECCENTRIC ORBIT, a satellite would see the whole disc of Earth from about a 3000-mi. apogee. Dr. Harry Wexler, late chief of the Weather Bureau, theorized that systems would look like this in Northern Hemisphere. Tiros photographs (interposed black lines) have already borne out his theory.*

• **Long-range program** — Underlying the flight programs of NASA's meteorological satellite group is a long-range program to discover better ways of getting weather information.

The two current methods are by TV camera and by infrared measurements. However, NASA is also investigating possibilities of taking nighttime cloud pictures and using other portions of the electromagnetic spectrum.

Scientists are now taking a close look at this spectrum to see if any portions (besides IR) correlate closely with temperature, pressure or winds of the atmosphere. At present, there is no way to measure these from a distance.

Dr. Morris Tepper, chief of meteorological satellite research at NASA, says he offers "a gold medal and meteorological immortality to anyone who can devise a way to measure pressure from a satellite." This measurement must be within .02% of a degree. The only way proposed at present is to put barometers in the ground and have them transmit information to satellites.

Another long-range consideration is the use of radar to discover precipitation areas. Its real value has not been decided, and a study contract is presently investigating this.

Spherics, the radio waves associated with thunderstorms, are also being studied at NASA. Met/Sat officials say that if their origin could be identified, they would probably be used to get a thunderstorm census of the world.

NASA also is supporting development by Radio Corporation of America of an electrostatic tape for meteorological satellites, which would combine with the camera for storing of photographs. This would be a non-destruct readout system, which could permit any country with proper receiving equipment to interrogate the satellite and read it out without destroying the information.

This equipment is expected to be ready sometime after the fourth *Nimbus*.

Sounding rockets, still the bulk of Goddard's day-to-day effort, will be launched at the rate of about 30 per year for meteorological and aeronomical research.

In addition, meteorological experiments will be carried on other research satellites, specifically *S-6* (atmospheric structures satellite, slated for launch the the first quarter of 1963) and *EOGO* and *POGO* (orbiting geophysical observatories.)

Goddard officials also indicated they are working out plans to put meteorological packages on Venus- and Mars-bound spacecraft.

NASA, DOD and the Weather Bureau cooperate through the Joint Meteorological Satellite Advisory Committee (JMSAC).

• **Tiros**—The program now undergoing the greatest planning activity is the *Tiros (Television InfraRed Observation Satellite).*

Negotiations are now being completed with the Weather Bureau to fund an additional four satellites. NASA will add three, bring the total number to 15. (The first two in 1963 have already been funded.)

These may be launched 36 days apart to orbit in pairs at opposite points over the Earth. One satellite in each pair would be a conventional one, essentially an "operational" model (*Tiros* is still an R&D program). The other would be available for NASA's R&D experiments, but would provide as much operational information as possible.

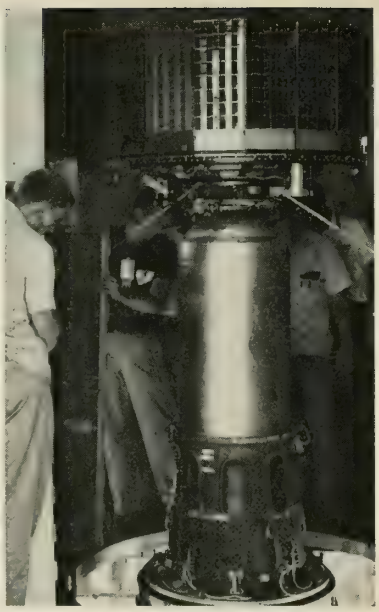
Almost all NASA Met/Sat officials told M/R that the *Tiros* program was almost *too* successful. In the first six launchings, the cloud pictures in particular have been so good, they said, that too much emphasis has been placed on the satellite's operational use. *Tiros* still has a myriad of research uses, they said. Among the things being considered:

—*Polar orbit,* in preparation for *Nimbus. Tiros* could carry some *Nimbus* components such as horizon scanners. And it would help break in the PMR crews for Met/Sat launchings.

To launch into polar orbit, a *Thor-Agena B* might be needed. This would leave about 400 lbs. additional payload available besides *Tiros,* so NASA is looking for another satellite to team up with.

—*Eccentric orbit.* Among the next few *Tiroses* one undoubtedly will be launched into a highly elliptical orbit, probably about 300-300 miles. Met/Sat officials say that at apogee the satellite will see the whole disc of the Earth, with a longer view of individual movements.

Orbit calculation problems face the eccentric orbit, and variations of inclination and payload weight are being calculated. In addition, some modifications may be made on the camera lens system, possibly using a combination of an Elgeet and a narrow-angle lens. Some transmitter change may be needed, possibly going from a 2-watt to a 10-watt system. This may put a strain on the solar cell system, but added sunshine may compensate. Some thought also has been given to going to a more efficient solar cell to compensate for this added power drain. However, these details have not been worked out yet.



*TIROS satellite may be used for polar orbit or eccentric orbit in new plans for research exploitation of the highly reliable spacecraft. Tiros is boosted by the equally reliable Douglas Thor-Delta rocket. Launch record is six tries, six successes.*

The eccentric orbit experiment was one which was forgotten when *Tiros* proved to be so successful. However, when *Tiros IV* went into an elliptic orbit (367-604) it revived the idea that such an orbit could be very useful in research.

If the eccentric orbit does prove beneficial, it may affect orbital plans somewhere in the *Nimbus* program, but officials conceded that this is pretty unlikely.

NASA spokesmen said the eccentric orbit would affect the operational use of the satellite somewhat, because the type of coverage would be different. Also, the introduction of unknowns might lead to some difficulties in handling. Thus the space agency said it would fund and direct all experimental *Tiroses,* but would make all efforts to get as much operational use out of them as possible for the Weather Bureau.

—*15-micron experiment. Nimbus*-type instruments will be flown in one of the early forthcoming *Tiros* satellites. The *Nimbus* horizon scanner will depend on measurements of the 15-micron region, which closely follows the Earth's horizon. NASA wants to test the scanner and check out the feasibility of using this region. This experiment would be most helpful if flown on the polar-orbiting *Tiros.*

Officials also indicated that they felt they had not gotten all the infrared information that they wanted. They feel that there is a need to get a complete global picture on a year-long basis. All the IR experiments, including the 15-micron one, are designed and administered by the Goddard Spaceflight Center.

A *Nimbus* acquisition station at Fairbanks, Alaska, will be modified and activated for *Tiros* use by the first quarter of 1963. This will give *Tiros* three stations, enabling NASA to meet its heavier launch schedule.

About 60 people will be needed to staff at Fairbanks—serving *Tiros* but getting experience for *Nimbus.* When *Nimbus* is phased in, both can be handled there.

*Tiros* has an amazing success story of launching, and an average satellite lifetime of about four months.

The percentage of pictures which can be used is phenomenal—running at 93% for *Tiros VI,* and 82% for *Tiros V.* This percentage includes all pictures attempted, including blank frames, etc.

The current *Tiros* launch schedule calls for one launch apiece in the first two quarters of 1963. However, if hopes succeed, the doubled-up schedule will begin as early as the second quarter.

*Tiros* dual launches would be planned to cover the prime times of concern to the Weather Bureau, such as the hurricane season.

*Tiros* launchings will continue until *Nimbus* outdates the system. This will mean some overlap, probably through the first two *Nimbus* launches at the end of '63 and beginning of '64.

The burden of dual operation will rest on the ground stations. Additional equipment and double shifts will be needed. And the pressure will be great, since operational information will be coming out of both satellites.

Goddard Space Flight Center is *Tiros* systems manager and calibrates all the systems. Radio Corp. of America does subsystems integration and integration of the IR into the spacecraft, and conducts environmental testing under NASA supervision. The radiometer was bought from Barnes Engineering Co., and electronics work was provided by Aero Geo Astro. Raymond Engineering provided the tape recorder.

Developers of the spacecraft say that *Tiros* will never have changeover redundancy, since this would necessitate a totally new development program.

• **Tireless Tiros**—All six *Tiroses* are still orbiting, with *Tiros I* the only one not transmitting at all. *Tiros II* has beacon transmission at 108.03 megacycles, *Tiros III* at 108.00 megacycles. Wallops Island station recently interrogated *Tiros IV,* and found that it was still transmitting TV, although with a great deal of distortion and degradation.

*Tiros V* is still in perfect operation with one camera. *Tiros VI,* launched early in case *Tiros V's* camera did fail



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during the crucial hurricane season, is transmitting photographs from both cameras at the rate of 600-700 pictures a day. Its total to date is about 25,000, of which 22,000 were usable.

• **Nimbus**—Although not a single *Nimbus* spacecraft has been launched, NASA officials are continually looking ahead to improved spacecraft, new experiments.

There is doubt that the *Thor-Agena B* will suffice for much more than the first two or three R&D satellite launchings. The *Atlas-Agena B* may be called upon for the task of lifting the later, heavier *Nimbuses*.

Among the innovations being mentioned:

—Radar.

—Image orthicon camera system (for photographing clouds under low levels of illumination).

—IR spectrometer.

—On-board analysis techniques.

—Ground data analysis and presentation systems to reduce amount of redundant data transmitted by the satellite.

—More comprehensive (400-mi.) sensors for gross measurements of the Earth-atmosphere heat balance and auxiliary measurements important to meteorology.

—TV vidicons.

—Electrostatic tape camera (being developed by RCA) for use after the fourth *Nimbus*.

Contracts for operation of ground systems and communications, not yet let, will be phased in as needed.

The *Nimbus* satellite was specifically designed with a modular concept so that new subsystems could be added as they are developed.

A top Goddard official also outlined for M/R some of the parts and components that NASA wants made more reliable, or supplanted by new, better systems—including new power supplies, which NASA hopes to find by the close of the decade. Because of the modular construction of the spacecraft, the solar paddles could be removed and a power unit could be placed on top of the controls box.

Other items the official named were: control systems, horizon scanners, reaction wheels, communication systems, bearings, lubricants and magnetic tapes.

The first two *Nimbus* spacecraft will have no redundancy of sensors. These will be used to test out the engineering feasibility of the system. The third *Nimbus* will have system redundancy, and the fourth will have subsystem redundancy or "integrated" redundancy. This will permit switching of parts from one system to the other.

Goddard is continuing its philosophy of careful and intimate control of development of components and their testing. A team of six NASA engineers will be in residency at General Electric's Valley Forge facility for the entire period of the spacecraft's checkout and testing.

*Nimbus* marks one of the greatest breakthroughs in spacecraft development. The procedures devised for testing the spacecraft's stabilization and controls system will affect testing of all major spacecraft to follow.

For the first time, engineers will be able to run a spacecraft with its stabilization and control system on a half-sphere air bearing in a closed loop. The air bearing is positioned in the spacecraft so that it holds it up, and the stabilization system points it at a simulated Earth, which fills 120° of the satellite's view. In addition, vacuum and temperature can be simulated.

Testing has just begun at Valley Forge, and NASA says it will be nine months before a flight spacecraft results.

Only the solar paddles cannot be tested under 1 g. Since the paddles are built for outer space, they are far too flexible to withstand proper flight tests under Earth's gravity.

• **Nimbus uses** — As outlined in Congressional testimony, *Nimbus* was designed to give such information as:

—Global cloud cover pictures, at least once in darkness.

—Winds in the operational environment of weapon systems.

—Height of clouds—bases and tops

—Amount and extent of precipitation.

—Atmospheric information—vertical temperature, moisture and density.

—Index of refraction.

—Height of tropopause and ionospheric layers.

—Surface pressure.

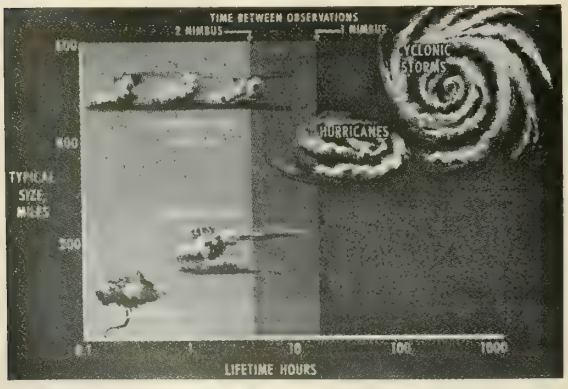
—Ground cover (e.g. snow, ice, vegetation).

It will be launched in polar retrograde orbit and will be Earth-oriented Orbit will be about 105 minutes.

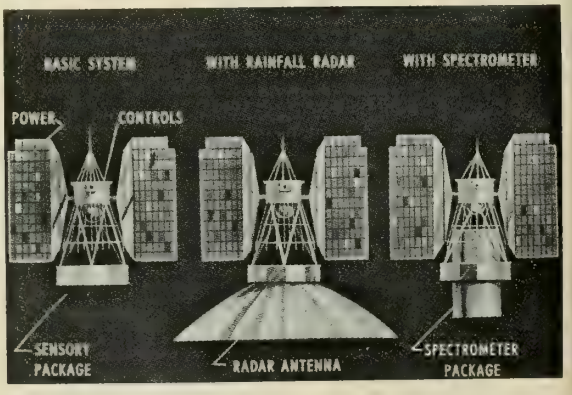
The early, simplified *Nimbus* will weigh about 600 lbs. and be launched by a *Thor-Agena* into a 500-600-mi.-altitude orbit. There is some possibility that later *Nimbuses*, weighing about 700 lbs., may be launched into higher orbits of about 750 miles. This higher altitude would be desirable since NASA would be able to reduce the number of readout stations from three to two.

About four R&D satellites will be orbited by NASA before 1965. During this time, the Weather Bureau will fund five additional satellites to give maximum operational coverage. They will be interleaved with NASA models and be copies of successful satellites.

The satellite is expected to be fully operational by 1967-68, and the Weather Bureau has indicated that it desires two in orbit from then on, probably three launchings a year. Lifetime of the satellite is expected to be about six months. ⌘




*SHORT lifetimes of typical weather systems show that thunderstorms and tornadoes may live and die between passes by Nimbus meteorological satellites. Aeros synchronous satellite concept would provide continuous viewing of all spots on Earth's surface.*




*SIMPLIFIED diagram shows versatility of Nimbus weather spacecraft. Modular construction makes it possible to add or subtract major systems. Operational target date is 1967-68.*




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# Kiwi Test Key to Nuclear Progress

***Hot run due before end of year will show whether Nerva can fly in '67; technology being transformed***




*NERVA—calculated gamble nearing moment of truth.*

UPCOMING TEST of Kiwi-B4 holds the key to the nuclear propulsion program's future rate of progress. Using a core configuration nearly identical to that of the flight-type *Nerva* engine, the Kiwi-B4 ground-run will acquit or shatter the decision-makers who have gone ahead with *Nerva* design without demonstrations of its soundness.

The Joint AEC/NASA Space Nuclear Propulsion Office, under Manager Harold B. Finger, is carrying out a calculated gamble under way in an effort to accelerate the nuclear rocket program. Selection of the core design for *Nerva* was based on theoretical evidence that it was the best available. However, actual tests of the design are scheduled for the Kiwi-B4 test, now expected before the end of the year.

Victim of a slowly skidding test date, Kiwi-B4 was slated for operation early this fall—then slipped into early November, late November, and now is scheduled for a hot run before the end of the year.

SNPO Manager Finger told MISSILES AND ROCKETS: "The next few tests are extremely important to our program, and flight in 1967 is what we're shooting for. . . . We have some routine problems with the test series, but the reactor has been at the test cell for several weeks and is being checked out."

• **Leapfrogging**—The $500-million-plus *Rover* program and the much less intensive nuclear-electric rocket program constitute NASA's major effort to leap forward beyond the energy limitations imposed by chemical combustion systems for space propulsion.

NASA's operating expenditures for *Rover* in the past three years have gone up significantly each year, and the ultimate cost of the program has been estimated at well over one billion dollars. The Fiscal Year 1961 figure for NASA's operating expenses was $16.1 million, FY '62 was $26.4 million, and FY '63 is estimated at $81.4 million. These figures include neither the AEC and Air Force participation nor the construction costs involved. The latter category alone has cost $136.5 million for facilities of all kinds.

With such stakes, SNPO is understandably anxious to get a proof-of-the-pudding test successfully carried out on Kiwi-B4 so that the decision to go ahead with the *Nerva* design will be vindicated. Confidence at SNPO is high, but the element of doubt remains to deter overconfidence.

Kiwi-B4 is the sixth reactor to be built for SNPO by Los Alamos Scientific Laboratory, an organization thriving on solutions of exotic problems, and two other reactors have been fabricated and are awaiting tests. In addition, LASL is designing two new types of reactors in conjunction with the industrial *Nerva* contractors, Aerojet-General and Westinghouse.

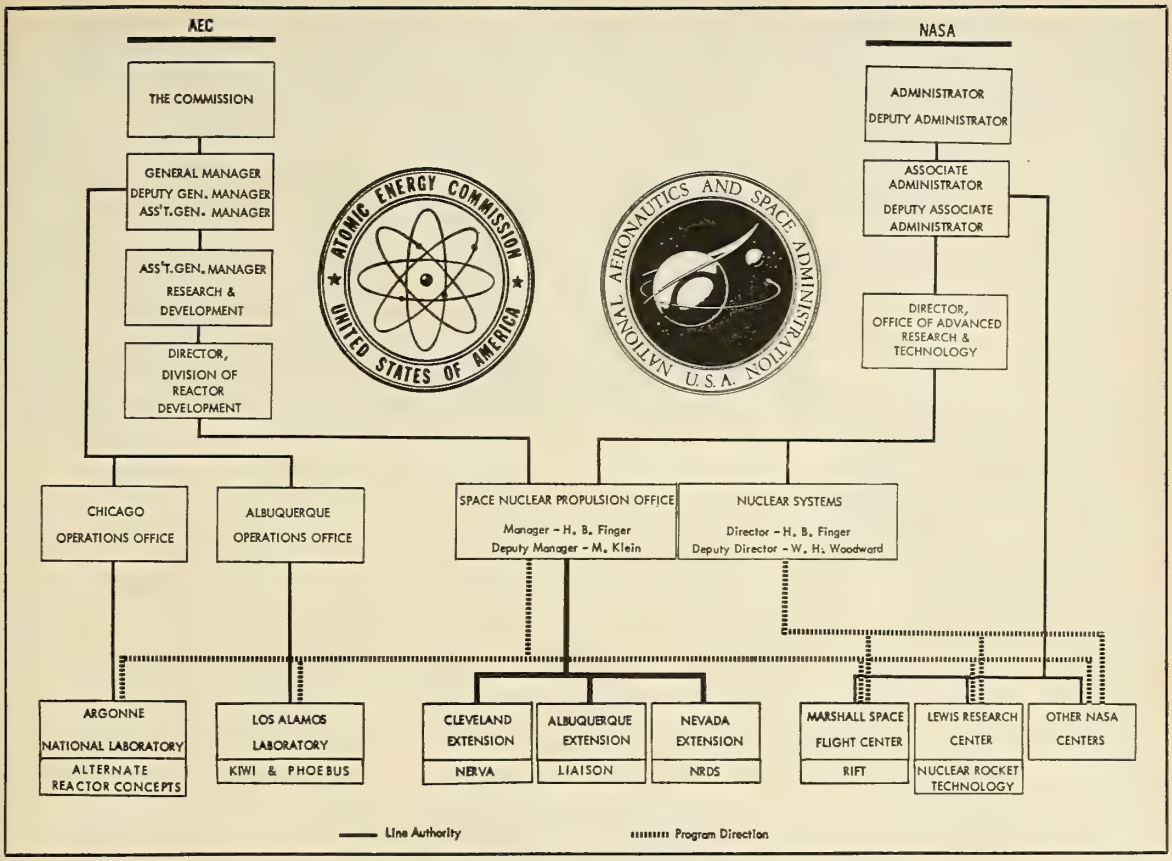
• **Progression** — The *Rover* propram, with its Kiwi flightless reactors acting as trailblazers for the flight-type *Nerva* (Nuclear Engine for Rocket Vehicle Applications), has now essentially determined the basic materials, core design and other elements of a flight version, despite the numerous technical problems which remain in specific areas.

Next month's scheduled test of Kiwi-B4 is largely to ascertain the soundness of the mechanical structure supporting the core against all the dynamic forces striving to tear it out of the reactor.

Kiwi-B1B, tested in late August and early September, was a flop, but this was no great surprise to project officials. After developing increased thrust following successful startup on liquid hydrogen—previously an unknown hazard in itself—the reactor suffered some damage and, in the words of one observer, "vomited its core all over the site."

A recurrence of this is what SNPO hopes to avoid through its redesign of the core support structure. Other changes will take place in the liquid hydrogen feed system, and perhaps in instrumentation.

• **Detractors**—The nuclear rocket program, managed by the joint AEC/NASA SNPO setup, is basically funded




for reactor development through AEC, and for non-nuclear components and overall engine integration through NASA. Little change is expected in the program's direction or management, despite some criticism by individual members of Congress.

Some complaints have been voiced within NASA that SNPO is seriously neglecting nuclear-electric propulsion in favor of *Rover*, in spite of the fact that a nuclear-electric propulsion system is scheduled for flight in 1966—one year before the *Rover* flight test.

One of the principal complaints is that SNPO ignores the many near-Earth missions that can be handled by electric propulsion and relegates these engines to the task of carrying an occasional scientific package to a remote planet like Jupiter.

• **RIFT**—Notwithstanding the official earlier flight date of the nuclear-electric system, the reactor in-flight test *(RIFT)* has been described as "the earliest possible use of nuclear propulsion in space," apparently because the nuclear portion of the system merely provides electricity for an electric engine.

The *RIFT* vehicle, which uses the *Nerva* engine, is slated for four flights (one cold flow and three hot runs) and would double the payload of the *Saturn C-5* if used as a third stage in place of the chemical third stage.

*RIFT*, under development for NASA by Lockheed, will stand 100 ft. high, be 33 ft. in diameter, and weigh 150,000 lbs. all by itself. It will go into space from Pad 39 at Atlantic Missile Range and is the only firmly planned nuclear stage in the works. Others—intended for use on *Advanced Saturn* and *Nova*—are under study, however, and may use the advanced reactor concepts now taking shape.

These include gaseous-core, fluid-bed, dust-bed, and other concepts, as well as solid-core reactors weighing as little as 200 lbs. The latter, part of SNPO's *Phoebus* program for the development of future reactor types (M/R, March 19, p. 16), is an LASL design enabling the user to get either small reactor size and weight, or, by increasing the size, to get higher power densities and exit gas temperatures. Finger feels the high temperature aspect is more important than the potential for light weight.

The overall contract for the *RIFT* stage, materials for which will be tested at Lockheed's Dawsonville, Ga., radiation facility, covers a six-year program involving ten stages. Five of these will go to NRDS for ground tests, beginning late in 1964. One will go to Marshall Space Flight Center for "shake, rattle and roll" non-firing dynamic tests. The remaining four will go to Cape Canaveral for launching aboard *Saturn* boosters.

Materials used in the tankage of the first unit will be stainless steel and, because stainless steel is highly activated by neutron bombardment and its active isotope has a long half-life, it is presumed this will be the non-firing vehicle sent to MSFC for dynamic tests. Materials for the later stages have not been revealed, and these may still be under study for radiation effects.

Radiation may pose a severe problem for *RIFT* because at cryogenic temperatures the affected material cannot self-anneal. Existing data on this problem are sparse, as is the case generally with radiation effects, but particularly at cryogenics temperatures.

Damage to specific components must also be studied, with emphasis on stressed materials such as those in turbines and pumps, as well as guidance and control equipment. Further, the effect of radiation in increasing the temperature of the liquid hydrogen propellant is also an unknown.

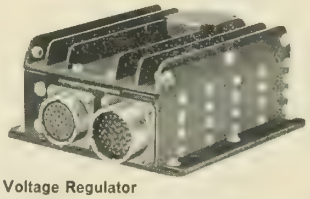
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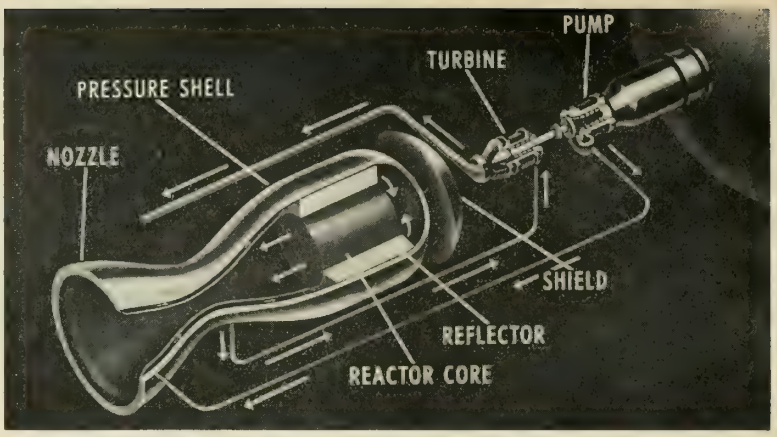



*DIAGRAM of typical nuclear rocket engine design showing chief components.*

NASA, have continuing programs on materials, cryogenics, high-speed rotating machinery and radiation effects on every conceivable type of material under consideration.

• **Transformations** — Profound changes in U.S. propulsion technology expected to accompany the first nuclear rocket flight in 1967 are already being felt in the fields of materials, facilities for nuclear vehicles, cryogenic fluids, high-speed high-temperature pumps and valves, heat transfer, exotic fabrication techniques and numerous associated fields through the effort in nuclear propulsion.

SNPO and LASL, and their contractors, may also revolutionize quite a few basic technical fields outside the propulsion area. The non-nuclear components of the program, being handled by NASA, would be applicable to virtually all hardware programs requiring severe tolerances, high reliability and exotic fabrication techniques.

Safety tests scheduled for the nuclear rocket program include two by LASL and NRDS, in which one reactor will be put through an excursion run and another will undergo simulated water entry. The first involves running the reactor to death to determine predictable levels of power pulses which might come as a result of malfunction. The water entry test will consist of injecting a column of water into the open end of a Kiwi reactor at approximately the velocity calculated for an offshore launching abort in which the vehicle would land in the ocean.

• **Enter Phoebus**—The safety tests will take place next year, as will the transition from reactor development to engine development.

Complete transition from the *Nerva* series of reactors to the advanced *Phoebus* reactors is expected to be complete by early 1964. First *Phoebus* reactor will closely resemble the Kiwi-B type, and specific design work has started on the follow-up version, *Phoebus II,* which will require a new test cell at NRDS.

Construction of facilities for tests of all nuclear rocket systems is now under the direction of PERT programs at the NRDS in Nevada, and the major difficulties which were previously experienced with this phase of the program are expected to be greatly diminished (see Construction article, p. 154).

• **Standing firm** — Management of the program has come in for some criticism, and a mild difference of opinion has also marked the relationship of SNPO and LASL.

During hearings before the Joint Committee on Atomic Energy held in September, Rep. Craig Hosmer (R-Calif.) pressured Finger regarding the "excessive" duties he has as manager of a joint office handling several large programs.

Finger, who denies he is overloaded, said he is also unaware of any decisions on the program which were delayed because of his absences from his office.

"I've never really been 'unavailable,'" Finger told M/R. "Even last summer, when I took my family camping on an island in Lake George, a ranger came out in a boat to get me on the second day to answer a telephone call."

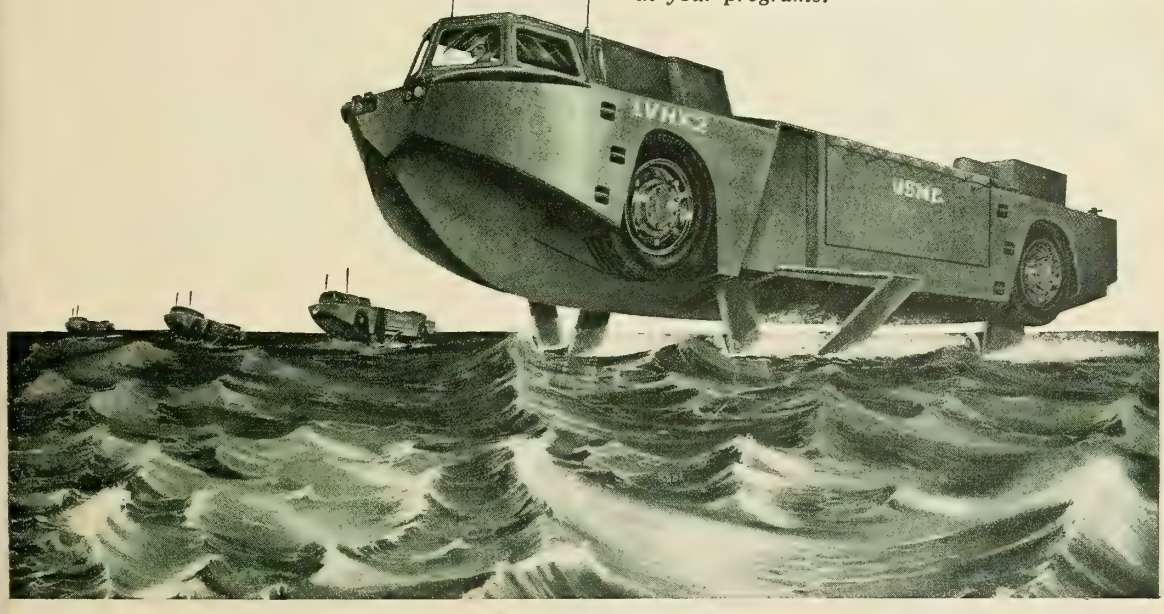
Despite the criticisms by Hosmer, no changes in the organizational setup of SNPO are anticipated.

A difference of opinion between Finger and Los Alamos over LASL's approach to managing its portion of the *Rover* program has come to a virtual impasse. Suggesting to LASL that they set up a single project office to handle the program instead of the current multi-division approach, Finger was greeted with refusal on grounds that the existing organization gives much better opportunity to bring the

# FMC ADDS "WINGS" TO AMPHIBIOUS RECOVERY SYSTEMS

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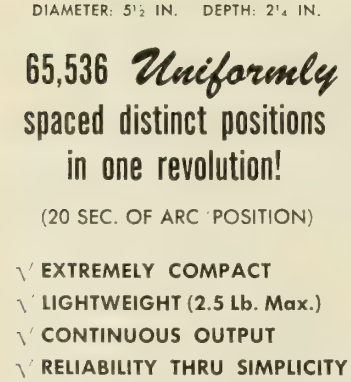



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Los Alamos, which is operated along division lines of technical specialties, feels it can better handle the job as it has handled weapons development and other assignments. Finger however, says LASL's Director, Dr. Norris Bradbury, misinterprets his definition of a "project office." According to Finger:

"A project office has no in-house work of its own—it is a management body, not a research group. LASL's N Division comes about as close to anything to being a project office, although J Division does field test work, T Division does theoretical work, and so on. They've got six divisions working on *Rover* and only a steering committee for official coordination.

"We can work under the present setup, but it's a big program. . . . We no longer pace ourselves with organizational problems because technical problems pace us. The organizational problems, however, complicate the execution of solutions. Dr. Bradbury is reluctant to set up a project office because he feels it would require setting up separate facilities and other major changes.

"What I have in mind, however, is just a little firmer coordination in the management aspects, not a major upheaval of the laboratory. For example, both N and J divisions, until recently, have had PERT programs under way on *Rover*. These are now in the process of being merged."

Aside from these differences between the two principal organizations of the program, however, there is considerable cooperation. Dr. Bradbury told the Joint Committe that LASL had been "overly optimistic" in stating schedules for completion of certain key activities and that this has been a source of slippage.

"It appears that too much reliance was placed (by LASL) on a quick, painless adaptation of existing chemical propulsion technology to nuclear propulsion. This reliance has not been justified in nozzles, propellant feed systems or controls. The new requirements of nuclear propulsion appear to require new, expensive and time-consuming development of hardware."

Bradbury told the committee the program has had trouble with high-pressure plumbing, remotely operated valves, gas line filters and hydraulic control systems. He said radiation environments have had some bearing on the troubles.

• **Pressing R&D**—Relative to these troubles, SNPO plans to invest in advanced research to the tune of some $15 million this year.

Requested in the budget for Fiscal 1963 was $780,000 for research on hydrogen properties; $1.94 million for radiation effects; $1.27 million for dynamics and control; $2.47 million for engine systems and components; and $1.56 million for advanced concepts research. This research activity on *Rover* and follow-on programs is separate from the research being carried out as part of the nuclear-electric program.

In power generation systems, the key to the nuclear electric concept, NASA plans to spend on research: $1.8 million for mechanical component research; $1.5 million for direct power conversion; $1.7 million on liquid metal research; $1.2 million for waste heat rejection; and $958,000 for advanced concepts studies.

The nuclear electric propulsion program, keyed to the *SNAP-8* power unit, is due for first flight test in 1966. The 30-kwc power system is a scale-up of the *SNAP-2* system by a factor of ten.

• **Ultimate SNAP**—*SNAP 8*, an extension of zirconium hydride reactor technology, is the limit to which it is felt this type of reactor can be pushed. The *SNAP-8* experimental reactor was assembled and went critical in September, and is expected to be ground-tested, complete with the NASA conversion equipment, late in 1964.

Aerojet is developing the power conversion subsystem for *SNAP-8* and integrating the overall electrical generating system. Reactor development is by Atomics International.

Missions for such a nuclear-electric propulsion system include spiral trajectories outward from near-Earth in order to take prolonged and consistent scientific measurements of the environment between Earth and Moon. Sporadic and inconsistent measurements result from periodic probes or satellites in fixed orbits, and a spiralling vehicle would improve the cislunar environment picture considerably. Other appropriate uses would be station-keeping for long-life satellites, and logistic supply vehicles for lunar bases and research stations.

One advocate of the nuclear electric system dismissed the Jupiter-probe mission as a fraction of the useful work a nuclear-electric rocket could perform.

"Why not put huge loads of unmanned equipment into orbit for transfer to the Moon?" he asked. "As long as there is no immediate requirement for the material, it doesn't require a high-speed trajectory, and is much cheaper than the huge boosters everyone is advocating. A slow, reliable, inexpensive nuclear-electric system used as a freighter can move tons of equipment while manned vehicles are free to get there in a hurry. After all, nuclear power is the key to space flight no matter what kind of rocket it powers." ⁂



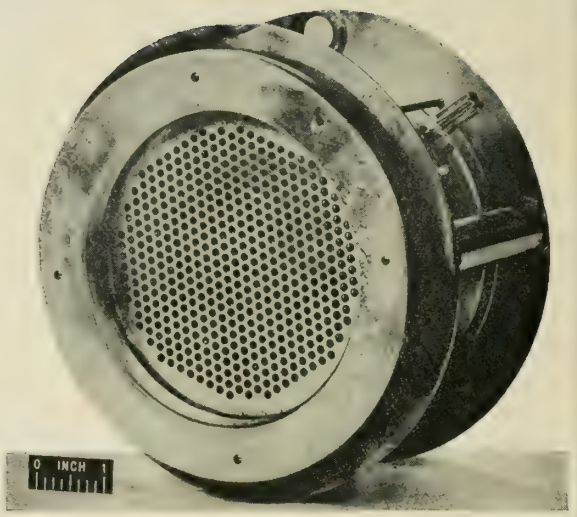

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# Wide-Ranging Research Attack Led by Lewis




*KAUFMAN permanent magnet engine.*

HAMPERED by low budgets and a slow-moving powerplant technology, NASA electric propulsion experts are nevertheless actively pursuing a wide range of ingenious approaches to the spacecraft propulsion problem.

Some of these new avenues:

—Development of permanent magnets for ion engines.

—Clustering concepts to increase thrust.

—Low-temperature magnetohydrodynamic generators through the "Kerrbrock Effect."

—Colloid and heavy particle concepts.

— A new approach to space electrical power generation involving the direct conversion of nuclear energy to electricity.

Electrical thrust devices have developed relatively rapidly in the three classical categories—electrothermal, electrostatic and electromagnetic—but the required nuclear power sources have not kept pace.

NASA and industry have been working on nuclear devices for the generation of power, but the materials problem—in light of the high operating temperatures required—is immense. To this can be added the difficult weight, reliability and life requirements characteristic of space applications.

• **Power through decay**—In a direct nuclear electrogenerator, the kinetic energy of charged particles emitted from a radioisotope by natural nuclear decay is used to produce a high-voltage current. This d-c power can then be used to accelerate charged propellant particles in an electrostatic rocket engine to provide thrust.

This eliminates the two-step approach to power in the nuclear-reactor turboelectric, thermoelectric and thermionic systems—where the nuclear energy is first converted to heat and then into electricity. The obvious disadvantages include weight, heat transfer complexes and poor efficiency in the thermodynamic cycle.

William R. Mickelson, chief of the Electrostatic Propulsion Components Section at the Lewis Research Center, says all nuclear disintegrations or reactions which are exothermic and appropriate as power sources impart their energy to the reaction products as kinetic energy or as electromagnetic radiation. Absorption of this energy in matter converts it to heat.

But, Mickelson continues, if the affected particles are electrically charged, work can be done by these particles in a properly oriented electric field.

An example of the general mode of operation would be a collector and an emitter positioned a given distance from each other. In this case the charged particles are emitted by a decaying radioisotope. Such particles are given off at the decay sites in various directions, but Mickelson says statistics for the process predict equal numbers in all directions when averaged over sufficient events. If there is a potential difference between the emitting surface and a collector, so that the resultant electric field might retard the motion of the charged particles toward the collector, then each charge reaching the collector has done work on the field.

If there is no external circuit between the emitter and collector, the collector receives one unit of charge while the emitter acquires an equal charge of opposite sign—the potential difference and energy of the field would increase until the retarding field became great enough to prevent charged particles from reaching the collector. In this manner a cell or voltage-generating device is formed.

In actual use, says Mickelson, an external load would be connected between the collector and emitter to complete the circuit. The operating voltage or potential difference would be adjusted at some value below the maximum where the number of charges reaching the collector equals the charge flow in the external circuit.

When this steady-state condition is achieved, the rate at which the nuclear-particle kinetic energy is converted into electric field energy is equal to the rate of electrical energy consumption in the external circuit.

• **Not for nothing**—This does not mean that all the nuclear energy is converted to electricity. The random direction of emission causes some particles to have an insufficient velocity component oriented parallel to the field; these do not reach the collector.

In addition, particles lose energy on passage through matter, and the fuel layer cannot be infinitesimally thin and still produce power. Thus those particles emitted below the fuel-layer surface lose energy while passing through the radioisotope itself.

Again, any excess energy in the particle on reaching the collector is dissipated at penetration in the form of heat. In all cases where energy is lost in the emitter or the collector, it is transformed into heat. This lowers ef-

ficiency and poses a heat disposal problem.

Mickelson justifies the choice of a radioisotope as the emitter on the grounds of weight-per-unit power. Any nuclear reaction producing charged particles could theoretically serve as a fuel source. The fission process gives off the most energy per event—it looks attractive until the high energy loss in materials for fission fragments is considered. The fuel layer must be of the order of micrograms/cm²—requiring an immense area. In addition, the process is not self-sustaining and needs a neutron source, which demands a critical reactor design.

A radioisotope source prepared on the ground before the mission appears to be the only fuel source that is competitive on a weight/unit power basis—especially against a conventional nuclear reactor employing a thermal cycle system.

The natural or artificial radiosotopes emitting beta and alpha particles are suitable as the fuel in a direct nuclear electrogenerator system, Mickelson says. Charged particles emitted from these radioisotopes have energies in the 100-kev-to-5-mev range, so the cell will produce a relatively high direct-current voltage.

Design studies of several conceptual spacecraft have been made by Lewis experts, mating the direct nuclear electrogenerator with specific electrostatic engines—primarily colloid devices.

One such concept involves a spherical configuration with an alpha-emitting radiosotope film on the surface of the inner sphere. The outer sphere acts as the collector.

The collector is floated at space electric potential, and the inner sphere then carries a negative charge. An electrogenerator of 500-kilowatt capability was chosen to evaluate the concept. The radiosotope involved is polonium 210, although Mickelson says cerium 144 would probably serve just as well.

The collector is about 135 ft. in diameter and the inner emitter diameter is about 45 ft. The radiosotope total mass required is about 30 lbs. Detailed design studies show a total system weight for both the generator section and the propulsion system of about 265 lbs.—or a specific powerplant weight of about 0.5 lb. per kilowatt!

Studies have shown that the size of the system can easily be scaled downward to power levels of the order of 30 kw without any increase in specific system weight. This makes the system of considerable interest for interplanetary space probes.

The use of cerium instead of polonium would require radiation shielding of the payload package—representing an additional weight of 1200 lbs. for a typical configuration. Even this results in a specific system weight of 3 lbs./kw—an order-of-magnitude reduction over current systems which, it is hoped, may reach 10 lbs./kw.

Basic and applied problems abound in the direct nuclear approach. There are physics problems: whether particles will knock electrons out of the support foil, the sputtering of the collector and emitter support materials, and high voltage breakdown between the collector and the emitter. Engineering headaches include packaging of the isotope during launch and the dissipation of the high heat output. Merely obtaining large quantities of radiosotopes other than cerium may be difficult.

Still other problems include insuring that the package will remain intact if the mission is aborted, producing lightweight insulators with small leakage, and developing methods for depositing and attaching isotopes in thin films to the emitter surface.

Studies are in progress on some of these, and several small experiments in basic physics are under way. Mickelson feels that the direct nuclear system promises to be a very-high-performance propulsion system. Theoretical performance in Mars and Saturn orbiter missions worked out to be as low as 35 and 190 days, respectively.

• **Push in magnetics**—Another major spacecraft propulsion concept involves the nuclear fusion engine, and considerable effort is being expended on fusion power. Nuclear engines more or less compete with electrical propulsion systems, although practical economics will dictate mission regimes best handled by one or the other.

In the development of fusion power for flight vehicles, one of the two main problems is containment. The other, of course, is heating plasma to thermonuclear temperatures. The approach to containment is through strong magnetic fields, and the application of these to magnetohydrodynamic power generation is well known. There are also magnetic nozzles and shielding of spacecraft from high-energy charged particles.

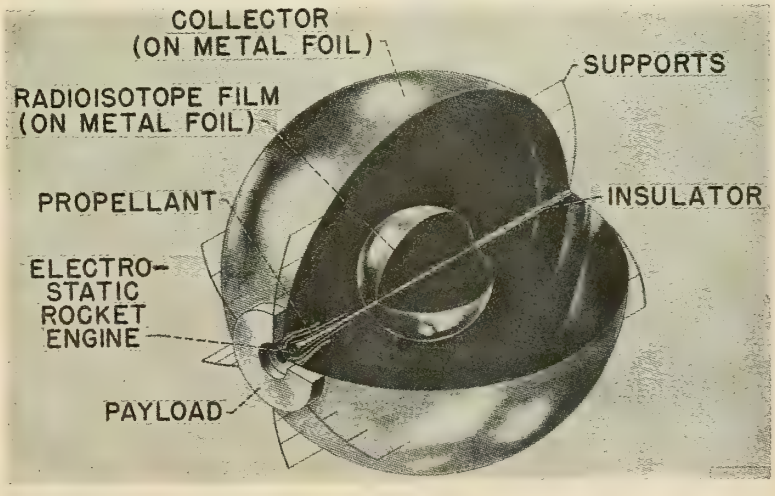
MHD power generation avoids some of the problems associated with rotating power equipment at extremely high temperatures. But it appears feasible only if the required magnetic fields can be generated through super-conductors.

The achievement of steady-state operation in intense magnetic fields over reasonably large volumes is a considerable achievement in itself, according to Edmund E. Callaghan, assistant chief of electromagnetic propulsion at Lewis. Space applications also demand light weight and low power consumption, further confounding the problem.

• **Ion flight close**—In electrostatic propulsion research, the electron-bombardment engine invented and developed by Harold R. Kaufman at Lewis is undergoing vacuum chamber tests and will be launched in the near future as part of the SERT package. A Hughes Aircraft prototype will accompany it.

One development in the Kaufman-type engine is the evolution of a permanent magnet in place of the field coil. The magnets are in contact with sheets of ferromagnetic material at the front and in back of the engine, inducing the requisite weak field throughout the ionization chamber.

Not only does this procedure eliminate the power requirement of the field coil; it also simplifies and lightens the power-conditioning equipment by reducing by one the number of separate power supplies. The weight of this engine corresponds closely to the weight of the field coil model.



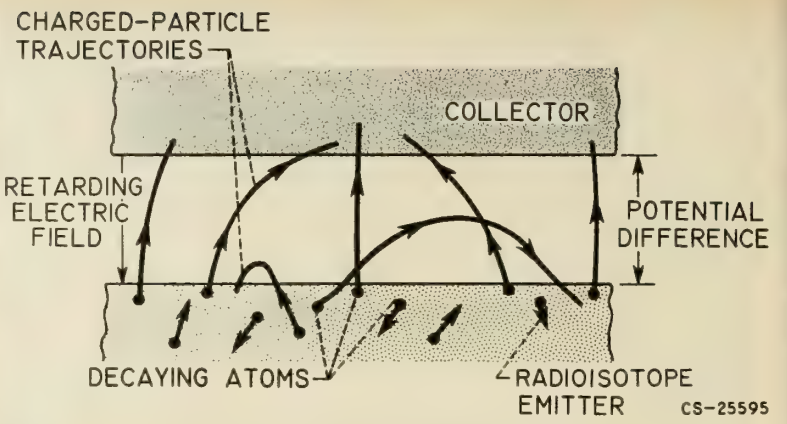

*SPHERICAL CONCEPT of a spacecraft using the direct nuclear system.*

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*SCHEMATIC operation of the direct nuclear electrogenerator.*

Another electrostatic engine concept is the contact ion type using cesium as the propellant with a hot ion emitter. The potentialities of this engine and those of the Kaufman variety have been well demonstrated, but work is required on both to improve factors of thrust-to-weight ratios, efficiencies and durability.

A third category of electrostatic engine, offering distinct promise for high efficiency in the low-specific-impulse region, is the oft-mentioned colloid rocket. Although its development is in extremely early stages, Warren D. Rayle, chief of the Advanced Concepts Branch at Lewis says the device may perform as well in its own region as the electron-bombardment engine does at high specific impulse.

The colloid engine uses particles of 100,000 atomic mass units or more, and difficulties have been found in producing, charging and accelerating such tiny particles. One frequent problem is the production of atomic or molecular ions, which consume much more power than their thrust is worth at the high accelerating voltages.

Besides the potential of high efficiency at low specific impulse, the colloid engine is promising because of possible application with power-plants capable of supplying megavolts directly such as the nuclear electrogenerator covered earlier in this article.

Besides straight-line extrapolations in engine development, NASA experts point to the relative lack of effort in the interface area between powerplant and engine—the power-conditioning equipment. These components will be subject to stringent requirements in weight and reliability.

In addition, says Rayle, system optimization may demand that the characteristics of the thrustor be compromised in the interest of compatibility with other components.

Another area covers the clustering of electron-bombardment engines. With this attempt at multiplicity come system problems in the power supply. For instance, if all propulsion modules are connected in parallel to a minimum number of power supplies, separate high-voltage circuit breakers are required for each module—and no reliable flight-weight breakers exist. There are also the magnetic field considerations about each module, which govern the distance between each engine in clusters. Research on the basic engine should be almost completed during the coming year, with a shift in activity to clustering concepts.

• **Plasma problems** — While many avenues are under investigation in electromagnetic propulsion, no device has yet demonstrated the performance required for actual propulsion mission, says George R. Seikel, chief of the Lewis Plasma Flow Section. But he adds that no fundamental obstacles have been discovered that would prevent the eventual achievement of this aim.

The major problem in plasma engine development can be laid to a lack of fundamental knowledge in plasma physics and an equal lack of sufficient plasma diagnostic techniques to adequately evaluate the experiments being performed.

Potential high efficiency in the 1000-to-5000-sec. $I_{sp}$ range is due to the possibility of efficient utilization of the plasma's ions—since in such devices the ionization and acceleration processes can be integral, the ions being accelerated as produced.

A program under way at Lewis, under Lester Nichols, is investigating the feasibility of applying the "Kerrebrock Effect" to MHD powerplant schemes. The effect, so called because of the work on the phenomenon performed by Dr. J. Kerrebrock at the California Institute of Technology, is being actively pursued by General Electric and others in MHD power generation.

Basically, the procedure makes use

# SOFTWARE

The hardware for space travel is coming along nicely. The software for space travel is people, about whom a great many issues are clear and some are not. Clear: a man can survive a few hours out there. (Nikolayev, 96½ hours, no known after-effects.) To be determined: can a man survive in space for weeks, or months? (On a round-trip to the moon, for example. Or in an orbiting space station.)

The most versatile and valuable component of any space system is man. His welfare out there is going to depend (in part) on the environment inside his vehicle. And the composition and pressure of that environment will depend on engineering requirements: weight, power, reliability. Suppose a pure oxygen, low-pressure environment were selected. How would our Astronauts function during a two-week mission?

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the second and 3.8 psi for the third. A fourth group, breathing air at 14.7 psi, serves as control.

Outside the chamber are specialists in aerospace medicine, physiology, psychology, microbiology, biochemistry and environmental testing. During each two-week period this team performs 683 specific tests on each man (mental, sensory, motor, pulmonary, hematological and microbiological.) The group is assisted by instruments (polygraphs, oscillographs and the like) that automatically monitor and record each subject's reactions.

Probably the most significant oxygen pressure in the test program is 5 psi. That's the environment currently used for Project Mercury. It is also under consideration for Project Gemini, a planned two-week orbit for two Astronauts. Long before they go up, the "unknowns" of living in an oxygen environment will have become knowns. And the hazards thereof, if any, will have been pinned down, studied and eliminated.

This research, supported by NASA, is being carried on in our Space Environment and Life Sciences Laboratory, to determine the effects of space travel upon the software as well as the hardware.

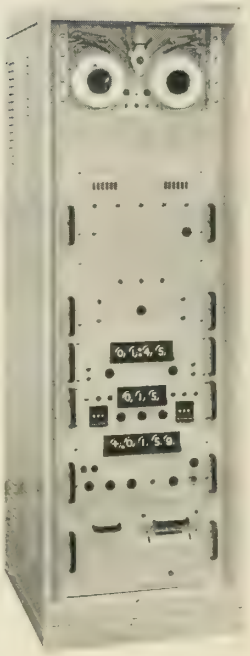
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of the magnetic field already present in an MHD device to produce electrons without the need for very high temperatures. When an electric current flows in a gas, the few already present electrons reach higher temperatures than the gas itself. By adjusting gas composition and magnetic field, electrons can be made hot enough to create ionization of a suitable additive gas without providing heat from an external source.

The Lewis effort is basic—aimed at answering such questions as how is the creation of ions related to electron collisions and how many collisions will result in net losses due to recombination.

Initial steps will involve building an MHD generator, but this will not be a net power unit—feasibility is a major interest. Should the concept prove out, the normal problems remain in conversion to useful space hardware.

While there is a considerable reduction in the operating temperature input, the regime is still in the 2500°F area and this will require some materials development if the process proves promising.

The third general area in electric propulsion at Lewis involves electrothermal thrustors or arc jets. These devices cover missions, such as Earth orbit, requiring specific impulses in the 1000-sec. range. Here the propellant is heated electrically before being expanded in a conventional convergent-divergent nozzle.

Two engine configurations are under study at the NASA propulsion center, says John R. Jack, chief of the Electrothermal Branch. The first is an experimental arcjet consisting of a cathode and anode which also serves as a convergent-divergent nozzle.

The second is a resistance-heated hydrogen rocket designed for a thrust of 1 lb. and an $I_{sp}$ of 1000 sec. The first engine has problems in propellant choices, electrode mission life and cooling techniques. The resistance-heated device has disadvantages in its operation—it needs a metal heat exchanger. Since the engine must use hydrogen, storage space poses a problem.

In general, says Jack, research in the past few years has narrowed the gap between experimental models and a flyable prototype. The lifetime of components, initially measured in minutes, has been extended to weeks. Specific impulses have been pushed into the 1000-to-1500-sec. range, and it now appears feasible to design an engine having the desired performance characteristics and conversion efficiency.

Problems are centered in reliable electrodes and heat exchangers, noncryogenic propellants and local convective heating rate measurements in propellants to determine the type of cooling system needed. ■



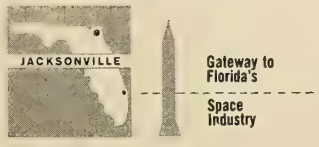

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# Building Cost May Peak Over $1 Billion in FY '64

***Only early start on Nova development can maintain such a level; a breakdown of planned facilities by centers***

CONSTRUCTION of facilities in NASA's Fiscal 1964 budget may top $1 billion as the peak is reached in the "brick and mortar" phase of the Manned Lunar Landing Program. After next year, however, construction should fall precipitately—unless a decision is made to initiate *Nova* development in FY '65.

NASA officials refuse to discuss next year's budget program. But they point out that they testified before Congress that peak construction spending was not reached with the $818 million requested for '63. And they admit that the FY '64 construction request will be "somewhat higher" than this year's—mainly because construction expenses must peak in the first couple of years of any program and then taper off as R&D costs build up.

The only program which could prevent a sharp reduction in construction funds is *Nova*. However, it is clear that NASA plans *Nova* development for the FY '66-'67 period—or perhaps beyond.

Support for the $1-billion figure next year also can be seen in the almost $71-million reduction in construction funds that NASA has already been forced to make, and the further reduction which may be necessary to support the *Apollo* program.

Part of this drop came from Congressional action trimming the original request from $818 million to $786 million. The remaining reduction—approximately $38.6 million or about 5% of the appropriated funds—reflects transferral to R&D accounts, most notably to the Manned Space Flight program.

This gives NASA some $747.6 million for its construction program. Of this, $471 million, 63% of the total, will be used to build testing, fabricating and launching facilities for the *Saturn*, *Advanced Saturn* and other launch vehicles. Ground facilities needed for the development and testing of spacecraft and for instrumentation research involve $120 million, or 16%, while an additional $45 million, 6%, is spent for tracking antennas and communications networks. About $112 million, or 15%, of the construction budget is allocated to the building of general laboratories or specialized research and advanced technology equipment.

**NASA PROGRAM FOR CONSTRUCTION OF FACILITIES**

(In millions)

| CENTER | BUDGET REQUEST FY '63 | CONGRESS APPROVED | PLANNED SPENDING |
|---|---|---|---|
| Ames Research Center | 14.439 | 14.439 | 14.439 |
| Atlantic Missile Range | 359.963 | 328.333 | 326.000 |
| Facility Planning and Design | 10.000 | 8.000 | 5.500 |
| Flight Research Center | 1.807 | 1.807 | 1.807 |
| Goddard Space Flight Center | 23.780 | 23.746 | 18.000 |
| Jet Propulsion Laboratory | 10.360 | 10.347 | 10.360 |
| Langley Research Center | 8.092 | 8.081 | 8.881 |
| Lewis Research Center | 43.833 | 44.833 | 44.833 |
| Manned Spacecraft Center | 30.755 | 30.755 | 41.000 |
| Marshall Space Flight Center | 33.437 | 33.432 | 33.437 |
| Michoud Plant | 18.400 | 18.400 | 18.4 |
| Mississippi Test Facility | 92.500 | 92.500 | 92.5 |
| Nuclear Rocket Development Station | 40.000 | 40.000 | 17.00 |
| Various Locations | 127.332 | 127.279 | 111.179 |
| Wallops Stations | 4.3 | 4.286 | 4.286 |
| SUB TOTAL | $818.998 | $786.237 | $747.622 |
| TRANSFERRED TO R&D | | | 38.615 |
| TOTAL | | | $786.237 |

• **New slashes possible**—Since NASA officials do not expect to ask for a supplemental appropriation in January, further reductions in programs other than manned space flight could take place. Mainly, these would be decisions to postpone construction of facilities which, it is felt, are not absolutely necessary at this time.

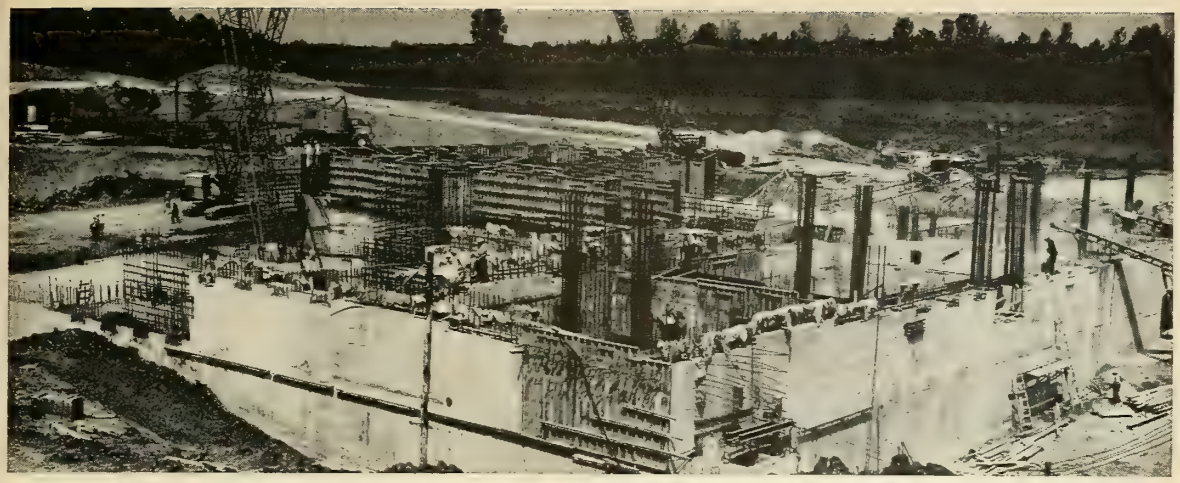
For example, the $3.9-million Launch Phase Simulator at Goddard Space Flight Center already has been postponed, and consideration is being given to postponing the $6.2-million Lunar Propulsion Research Facility at Lewis Research Center. A decision on the latter has not been made, however, and probably will not be made until next spring when the final design is submitted.

At the Atlantic Missile Range, some $18.9 million for *Nova* construction will not be spent, since *Nova* facilities are to be funded at a study level this year. However, NASA is considering the possibility that it will have to build another *Agena* launch complex at AMR in addition to further modification of the *Centaur* launch area. Of the appropriated $328 million, $326 million probably will be spent this year.

In addition to postponement of the Launch Phase Simulator, the Applied Sciences Laboratory at Goddard has been funded out of reprogramed FY '62 funds, but this reduction in this year's program is offset to some extent by the decision to build several general-purpose buildings to be used initially as office and laboratory space and eventually to become warehouses.

The $800,000 increase in Langley Research Center funding is NASA's share of a joint project with the Air Force to build a new access road at Langley AFB, Va. No real change in funding for either Marshall Space Flight Center or the Michoud plant is expected.

Although part of the $92.5 million appropriated for the Mississippi Test Facility was to have been spent on *Nova* static test facilities, there is no planned reduction in funding for the site. The



*WORK UNDER WAY at Marshall Space Flight Center site of F-1 powerplant test stand.*

funds instead will be used to construct static test facilities for the *Advanced Saturn's S-II* stage.

The $6.5-million Lunar Landing Simulator at Houston's Manned Spacecraft Center will not be built because NASA feels that there may be better methods available to train astronauts for landing on the Moon. For example, it is exploring free-flight methods in which five-sixths of Earth's gravity could be taken up by a thrusting device while the other one-sixth could be throttled by the astronaut.

This decrease in funding, however, is more than compensated for by the decision to push ahead with the $30-million mission control center. Overall funding for MSC has, therefore, increased from $30.8 million to $41.0 million.

Perhaps the largest percentage reduction in construction funding has been the cut from $40 million to $17 million at the Nuclear Rocket Development Station. This reflects a decision by NASA to postpone the construction of stage facilities at the Nevada site. Depending on the outcome of the Kiwi-B4 tests to be conducted this year, these funds could be restored. However, it appears extremely unlikely that this will happen.

The $16-million cut in construction at various locations is accounted for by the elimination of *Nova* manufacturing facilities. Advanced facility planning and design funds have also been cut from $8.0 million to $5.5 million.

Apart from Marshall and Michoud, Ames Research Center, the Flight Research Center, the Jet Propulsion Laboratory and Wallops Station are the only major NASA facilities to escape drastic changes in their construction programs.

• **Ames Research Center**—The $14.4 million appropriated for Ames this year—more than double the center's construction budget in FY '62—will be spent on four facilities:

—Biosciences Laboratory ($924,000) will provide research facilities to support research in the separate but related fields of immunology and genetics, radiobiology and exobiology.

—Mach 50 Helium Tunnel ($1,500,000) will be of the blowdown type with a test section 48 in. in diameter utilizing interchangeable axisymmetric nozzles to obtain Mach numbers of 30 and 50 at Reynolds numbers from 0.1 to 1.4 million.

—Radiative Heat System for Mass Transfer Facility ($2,225,000) will consist of radiative sources, both stabilized electric arcs and imaging optical systems, installed in the mass-transfer facility to provide a radiative heat flux to a heat-shield material at the same time that it is being subjected to convective heating from an arc-heated high-velocity air jet.

—Space Flight Guidance Research Facility ($9,790,000) is expected to simulate the environment, accelerations, motions and tasks for crew and equipment within a representative three-man capsule during take-off, midcourse flight, entry and landing, including simulation of abort or emergency conditions. Basically an advanced, pilot-controlled centrifuge, the design is based on operating experience with existing centrifuges.

• **Atlantic Missile Range**—By far the biggest hunk of NASA's construction budget ($326 million) is to be spent at Cape Canaveral. Nearly 90% of these funds will be for construction of launch facilities; the remaining 10% will be used to acquire 15,000 more acres in Brevard and Volusia counties to appropriately site the *Advanced Saturn* launch pads and, at the same time, accommodate the *Titan III* complex.

Heart of the Cape Canaveral facilities construction is the incrementally funded *Advanced Saturn* Launch Complex 39. It is funded at $176.5 million this year, but this is estimated to be only 40% of the total cost of the complex.

The FY '63 money includes the design and construction of a 460-ft. vertical assembly and checkout building, only one of the four *C-5* launch pads, the rail transfer system from the assembly building to the one launch pad, two launcher-umbilical-transporters and site preparation. Also included are checkout and control equipment, deflectors, firing accessories, instrumentation, ground support equipment and the design of the Ordnance Arming Tower.

Reflecting a change in concept, the Ordnance Arming Tower will be located at the *C-5* launch pad, thereby eliminating the need for the launch vehicle to stop en route to the pad. Once the *C-5* is on the pad, the arming tower will be brought in from a standby position to the vehicle where the explosive elements will be installed.

FY '64 funds are expected to provide for construction of the remaining three launch pads and their associated rail and propellant loading systems, as well as the construction of the arming towers.

*Apollo* Mission Support facilities will be constructed in the NASA industrial area at AMR at a cost of $22,510,000. These will include an $8-million spacecraft operations and checkout facility for modification, assembly, checkout and preflight testing of manned spacecraft and their mechanical and electrical components and systems. In the three-story masonry and steel building will be a high-bay area with two altitude chambers and two test pits and a low-bay fabrication and assembly area.

In the new area at Cape Canaveral, another set of supporting facilities, cost-

ing $39,121,000, will be built to house contractor personnel and the substantially increased range support instrumentation and equipment.

A $1.3-million contractor's building near Complex 39 will provide the proximity and working space required for coordination of the Manned Lunar Landing program. A $1.5-million engineering, laboratory and operations building also will be used for personnel engaged in test evaluation and checkout of parts, components, subassemblies, equipment and materials for booster and upper stages.

An *Apollo* static test facility with two test stands costing $5 million will be built to proof-test engines of the manned spacecraft's LEM and service modules. A steam ejector will be provided to simulate the space environment.

• **Manned Spacecraft Center**—Even with deletion of the Lunar Landing Simulation facility from the '63 program, the Manned Spacecraft Center has a '63 construction budget of $41.0 million. This brings the two-year facilities budget for MSC to more than $100 million of the approved $123-million construction plan.

With $7 million worth of site improvements and service installations just about completed, phase three—construction of the authorized technical and management facilities—is scheduled to begin this year.

The first technical building to be completed will be the Mission Control Center, which should be ready for installation of computers and communications equipment in August, 1963. On a highly accelerated schedule to permit its use in the *Gemini* program, the $30-million center will support all future manned space flights.

A $10.6-million flight acceleration facility will be built with '63 funds to provide an environmentally controlled dynamic simulator to be used by astronauts. A secondary purpose will be to provide a dynamic laboratory for studying psycho-physiological factors in the performance of individuals, to develop and perfect man-machine subsystems and to determine human tolerance to specific acceleration profiles.

The other project in the '63 program is a $6.0-million thermochemical test facility for evaluating and developing active spacecraft subsystems such as propulsion and reaction and attitude control.

The facility will have high-thrust test cells for both liquid and solid engines, a hydrogen and oxidizer component cyrogenic test cell, and a reaction control facility for tests of control systems up to 150 lbs. thrust. Chemical auxiliary power and static energy conversion systems tests, as well as heat transfer and rejection tests, will be conducted from a control room capable of remote operation of hazardous tests.

Other approved buildings in the Houston complex—all expected to be ready for occupancy by March, 1964, if not sooner—include a 10-story project management and engineering building; a flight operations building; astronaut training and life support; environmental test chambers; an antenna test range; spacecraft research building; structural test laboratory; electrical, electronics and optics laboratory; materials and mechanical systems laboratory; spacecraft environmental test facility; and life systems building and laboratory.

• **Marshall Space Flight Center**—Test facilities costing about $50 million are being constructed at Marshall Center to support development of *Advanced Saturn*. A $30-million, 405-ft. static test stand is already under construction and is expected to be completed in late 1963. A 450-ft. dynamic test stand is also planned to test all three stages of the *C-5* vertically for bending and vibration modes.

Funds are included in the FY '63 budget for completion of an F-1 engine test stand for test, evaluation and calibration of a single-unit of the 1.5-million-lb.-thrust engine. Initial construction was begun this year with reprogramed '62 funds.

The second *Saturn* static test stand in the two-position, West area—author-


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ized in the FY '61 budget and currently under construction—is to be converted to provide a capability for testing *Advanced Saturn* stages. This conversion is taking place under FY '62 reprograming authority and emergency authorizations. However, in order to properly instrument the test area for *C-5* stages, $4 million has been authorized this year. In addition, the final $2-million increment for test stand conversion is included in this year's budget.

An addition to the Computation Division building will provide space for needed vibrational, telemetry, optical, data translation and plotting equipment as well as an additional large digital computer and supporting equipment for a three-axis flight simulator. A new $4-million components test facility will supplement existing facilities, which are becoming inadequate due to physical limitations of the test cells and to the inadequate quantities of propellants that the cells can handle.

Three other buildings to be built from '63 funds include a five-story engineering and administration building adjacent to the new central laboratory and office, a two-story engineering building, and an instrument laboratory for work on measuring devices used in static test firings and cold flow testing. Combined cost of these three facilities is estimated at $5.5 million.

• **Mississippi & Michoud** — Over $11 million of the $18 million appropriated for the Michoud Operations will be spent this year to complete modification of the 825-acre plant. Most of this money will be spent to rehabilitate the World War II tank plant, but preparation of fabrication and assembly areas for the *S-I* and *S-IC* boosters are also under way.

Three new construction projects, totalling some $7 million, are also planned for the Michoud plant. The first is a $1-million high-pressure test facility for testing fuel tanks and high-pressure tubing of the *Saturn S-IC* booster. A $3-million Hydrostatic Test and Cleaning Facility consists of a building with an overhead clearance of 75 ft.—required in manufacturing the *S-IC* booster.

Adjoining this building will be a vertical assembly facility, also costing about $3 million, in which the final assembly of the *Saturn S-IC* booster will take place.

Construction is expected to start late this year on facilities at the Mississippi test area for static-testing the first two stages of *Advanced Saturn*. Four test stands—two for the *S-IC* stage and two for the *S-II* stage—will be built initially.

Some $92.5 million of the estimated $500-million total cost of the Mississippi complex is included in the '63 budget. Of this year's funds, $43 million was to have been used for *Nova* stage facilities. However, with *Nova* slipping at least two years, the funds will be used instead for *S-II* stage test facilities.

Some 15 miles of river channel will have to be improved and about 15 miles of canals, 15 feet deep and 200 feet wide, will have to be dug. To provide access from the East Pearl River, which connects with the Intracoastal Waterway, a lock will be built in the southeast corner of the area. Some $13.5 million has been provided for these support facilities and other utility installations.

In addition to the static test stands which are to be operational in 1965—the first *S-II* stand in early 1965, the first *S-IC* stand in mid-1965 and the remaining two stands by the end of the year—about 20 support and service buildings will also be constructed in the first approved $200-million increment.

The largest of these probably will be the rocket stage storage buildings, which will be about 200 ft. by 235 ft. with a ceiling about 70 ft. high. Other buildings include an engineering lab, acoustical lab, electronics and instrumentation lab, site maintenance building, central control, data handling cen-


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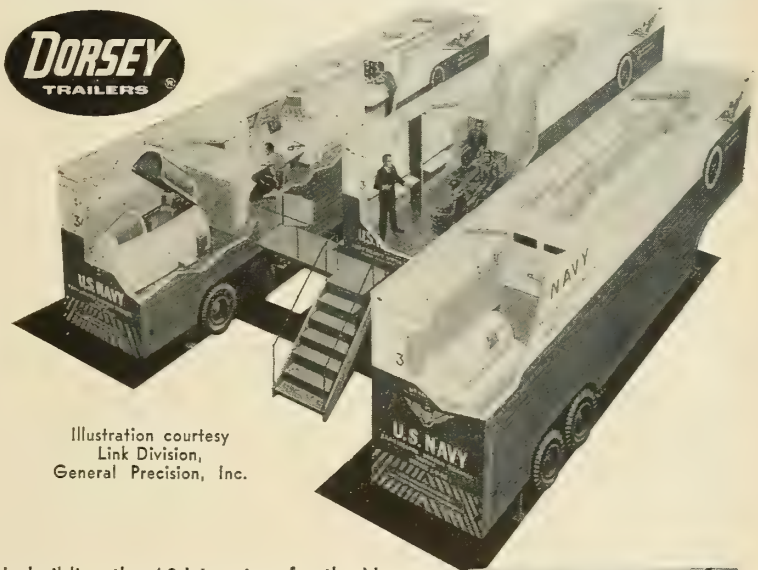
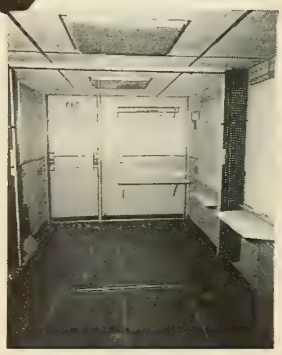



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ter and various other support facilities.

• **Goddard and JPL**—Two projects at Goddard Space Flight Center will consume $10 million of the agency's $18-million '63 budget: a Spacecraft Operations Facility and a Tracking and Telemetry Laboratory. An additional $3 million will be spent to convert a dynamic test chamber to a space simulator. A Development operations building and an attitude-control test facility make up the remainder of the construction budget.

The $7.5 million Spacecraft Operations building is an addition to the central flight control and range operations laboratory. It is expected to provide critically needed space for data reduction, control center, computation and communications equipment. Over $5 million of the total cost of the project will be spent to provide this badly needed equipment.

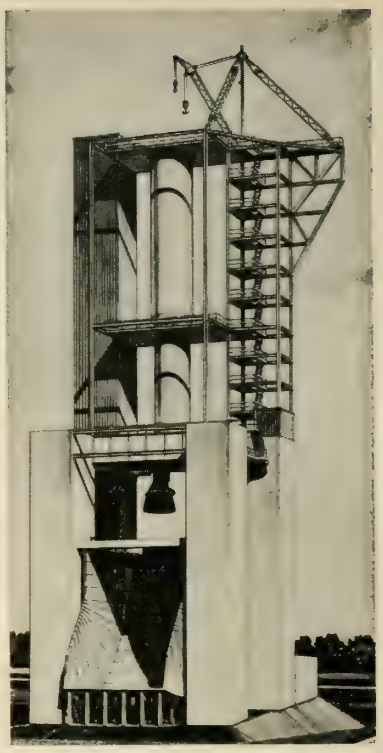
The tracking and telemetry laboratory will house additional scientific personnel for research and development of ground support instrumentation for tracking and data acquisition systems. Cost of the three-story building, with headhouse space for antenna test rooms and roof slabs to accommodate antenna loads, is estimated at a little over $3 million.

The Applied Sciences Laboratory—already funded from the FY '62 budget with reprogramed money—will house scientific personnel required for research and development of instrumentation for spacecraft and sounding rockets. Special equipment to be housed in the laboratory will include particle accelerators, leak detectors, a mass spectrometer, vacuum and thermal testing tanks, balancing equipment and gyro and hydraulic test stands.

The three major additions to the Jet Propulsion Laboratory—a Data Operations and Command facility, an Engineering Mechanics building and a telecommunications laboratory — total almost 83% of the $10.3-million '63 program.

The data operations facility is planned as the mission operations command center from injection to completion of a particular unmanned lunar or planetary mission. As such, the center will be fed data from the Deep Space network, computations of trajectory corrections will be made, and commands initiated at the command center to correct the spacecraft. At present these functions are performed in portions of four buildings and in 16 rented trailers. Cost of the building is expected to be $2.4 million.

Like the data operations facility, the engineering mechanics building and the telecommunications laboratory will allow personnel working on the unmanned lunar and planetary programs to vacate the substandard and rented facilities now in use. A $605,000 addition to the fabrication services building and a similar $600,000 addition to the materials research laboratory are the two remaining items of importance in the JPL FY '63 construction program.



*BIG STAND shown in artist's drawing will be erected at MSFC to test-fire C-5 engine clusters.*

• **Langley Research Center**—A stabilization and control equipment laboratory and a vehicle antenna test facility, plus additional equipment for magnetoplasmadynamics research are the major items in the Langley construction program for this year.

Over $900,000 also is provided for each of two facilities—one for environmental research for spacecraft components and materials, the other for a particle accelerator for simulated micrometeoroid impact studies.

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proved equipment.

The stabilization and control equipment laboratory will house inertial simulators, electronic simulation facilities for closed-loop integrated systems studies, and other equipment for trajectory analyses and control studies of lunar and planetary missions pertinent to investigations in re-entry aerodynamics and heating.

The proposed vehicle antenna test facility is required so that design, adjustment and development of new high-gain antenna systems can be accomplished effectively and economically to meet expanding vehicle requirements. An additional power supply and improved arc chamber for the 10 megawatt arc tunnel will be procured at a cost of over $700,000 to increase the capability of the tunnel to simulate re-entry conditions experienced by vehicles returning to Earth from lunar or planetary missions.

• **Lewis Research Center**—The major project at Lewis is a $25.5-million Space Propulsion Facility that will permit the evaluation and development testing of complete advanced power generation and electric propulsion systems.

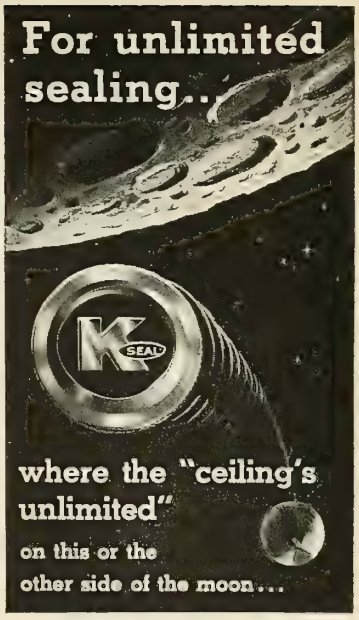
Designed specifically for testing both the *SNAP 8* power generation system and the electric propulsion system based upon it, the facility can also be used for more advanced systems at power levels greater than *SNAP 8* capabilities.

The building to house the facility will be approximately 100x350 ft. and about 60 ft. high. It will contain the space environment chamber, the pumping and power supplies, a shop and model assembly area, a control room and an operating nuclear reactor heavily shielded to protect the adjacent test chamber and the surrounding area. Cyro-pumping of the electric rocket exhaust will be done with liquid nitrogen baffles and gaseous helium. The facility will be located at Lewis' Plum Brook station.

A $2.4-million hydrogen heat transfer facility also to be built at Plum Brook will be used to delineate the heat-transfer and cooling analyses required for the development of optimum flight exhaust nozzles for nuclear rockets.

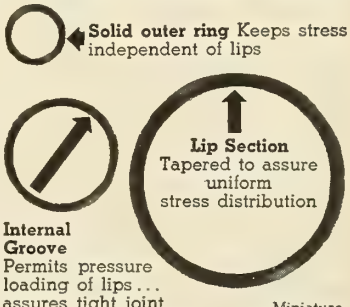
Another project at Plum Brook is a nuclear rocket dynamics and controls facility to investigate the basic nature of, and to develop solutions for, the control problems inherent in a nuclear rocket. A total of $3.5 million will be spent on this facility; an additional $1.5 million will be expended to modernize and recondition Plum Brook's service facilities.

Probably the hardest hit of NASA centers is the Nuclear Rocket Development Station, which saw its construction budget plunge from $40 million to $17 million. With the stage facilities cut from the Nevada test station's program,


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the major remaining items are a $7-million Radiation Effects facility and a $1.8-million Components Test facility. A little over $2 million will be invested in support facilities.

• **Edwards & Wallops**—The total construction program for the Flight Research Center at Edwards AFB, Calif., consists of $1.8 million, covering additions to the main center building for housing personnel added for work on the *X-15, X-20* and supersonic transport programs, and construction of a $475,000 visual flight simulator. Under this program, visual simulation will be added to the two static simulators already in use at Edwards.

A $1.5-million advanced data acquisition system and $2 million in modifications and expansion of range control, safety and support systems and equipment—plus $800,000 in vehicle checkout facilities and equipment—make up this year's $4.3-million construction program for Wallops Station.

The first project will up-grade the existing telemetry data acquisition systems at Wallops by the addition of a high-gain, multiple-frequency, automatic tracking antenna, pre-amplifiers, receivers and associated data handling equipment.

The range modifications will be accomplished by direct replacement of obsolete equipment, extension and updating of existing systems, and addition of new equipment. The checkout facilities are needed to handle space vehicles such as Algol clusters, and large solid-propellant vehicles with new and varied combinations of upper stages and increasingly complex configurations.

• **Various Locations**—Construction at other sites throughout the country was reduced some $16 million with elimination of the *Nova* stage manufacturing facilities. In addition, the $18 million originally in this category for the manned space flight control centers will be spent at the Houston spacecraft center.

Thus, overall spending for the line item "Various Locations" falls from a requested and approved $127.3 million to $93.2 million. Generally, three types of facilities are grouped under this category: $45 million for the large engine programs, $33 million for tracking and data acquisition, and $14 million for two test facilities.

Four single-position, single-F-1 engine static-test stands with associated equipment will be completed with the $25 million appropriated in this year's budget. Three of the stands were started with last year's funds, while the '63 money will provide the final increment for the Edwards AFB project in the Santa Susana Mountains. Total cost of the project is approximately $35 million, funded over the past two years.

Modifications of two existing *Delta 2* static-test stands and a *Delta 3* static-test stand—located also at the Santa Susana, Calif., propulsion field laboratory—will make it possible to use them for the 200,000-lb.-thrust $LH_2$-LOX J-2 engines under development for the *Advanced Saturn*. Total cost of the modifications is to be about $11.5 million, funded over the past two fiscal years.

Finally, funds are provided for building or modifying four dual static-thrust test positions for development of the 1,000,000-lb.-thrust M-1 engine. NASA feels that the $16-million increment authorized for this construction can be used to extensively modify existing facilities to give them an M-1 capability.

Antenna facilities approved for construction this year include an advanced $14-million antenna system at Goldstone station and new 85-ft. antennas at Johannesburg and Woomera costing a total of more than $10 million. The latter will enable these overseas Deep Space stations to handle the planned workload of the lunar and planetary spacecraft programs.

A $6-million Far East data acquisition facility—a high-gain, wide-band station equipped with an 85-ft. antenna and telemetry receivers—will allow NASA to acquire data from at least 60% of spacecraft orbits, a minimum requirement for such large spacecraft as *EGO* and *OAO*.

In conjunction with this station, an additional 85-ft. antenna will be installed at the Rosman, N.C., data acquisition station for use in the *EGO, POGO* and *OAO* programs. Initial funds for this antenna were provided in the '62 program, and the $3.5 million final increment is provided this year. It is expected to be available for use this year.

A $12-million Space Radiation Effects Laboratory is scheduled to be built in proximity to a NASA center and a university to enhance the programs of both. Basically, the radiation laboratory would be able to simulate the high-energy corpuscular radiation, both electrons and protons, encountered in trajectories or orbits of spacecraft.

A linear electron accelerator of commercial design rated at 2-10 Mev and a frequency modulated cyclotron for acceleration of heavy ions will be the principal pieces of equipment. Both accelerators will require substantial shielding—3-ft. concrete walls for the linear accelerator and 12-ft. walls for the cyclotron. Location of the radiation effects laboratory has not be decided upon.

Over $10 million has been transferred to a new construction site at White Sands Missile Range, N.M. These funds will be used to build launch telemetry and tracking facilities for *Little Joe II-Apollo* tests. ⁂

# The Decision Makers—
# NASA's Far-Flung Organization

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*NASA Administrator James E. Webb (seated left), Deputy Administrator Dr. Hugh L. Dryden (seated right), and Associate Administrator Robert C. Seamans, Jr. (seated center) at recent meeting with heads of all space agency centers.*



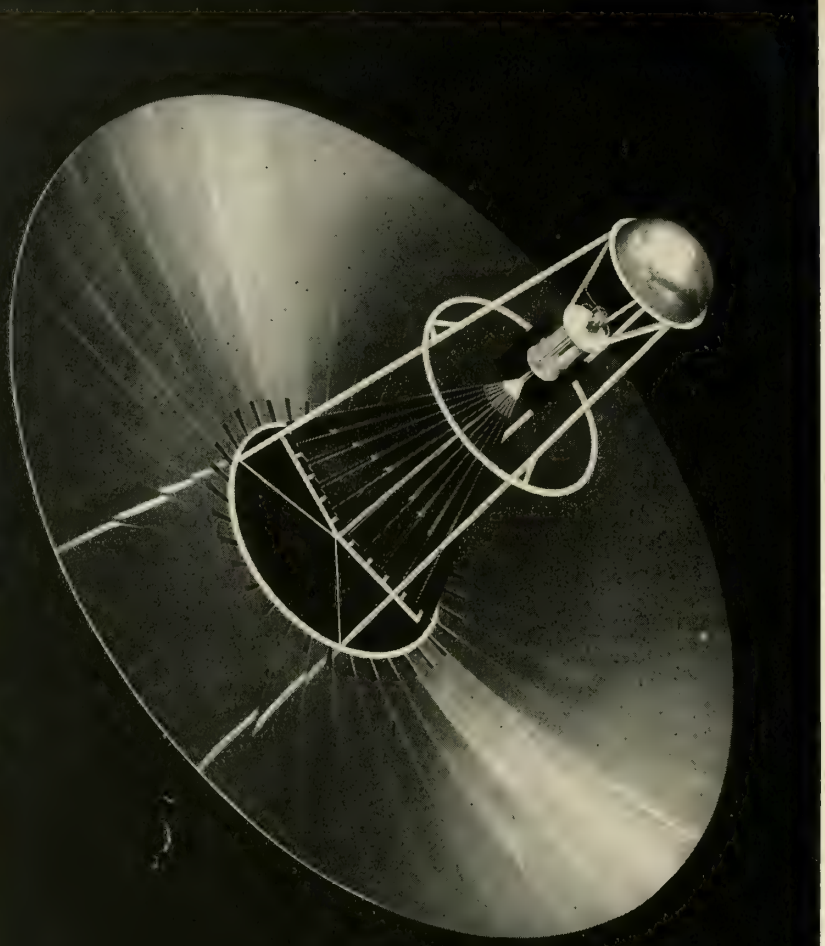
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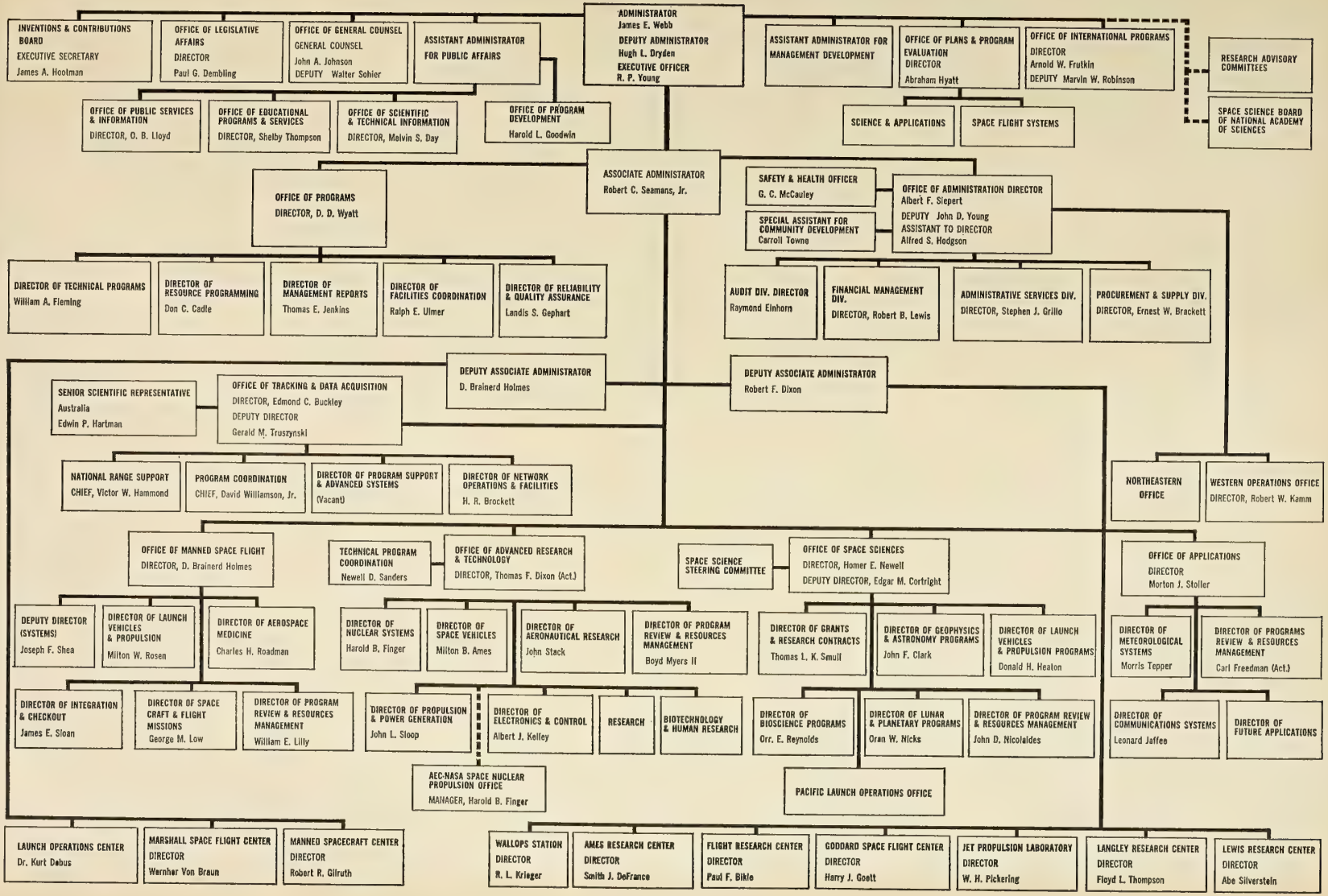
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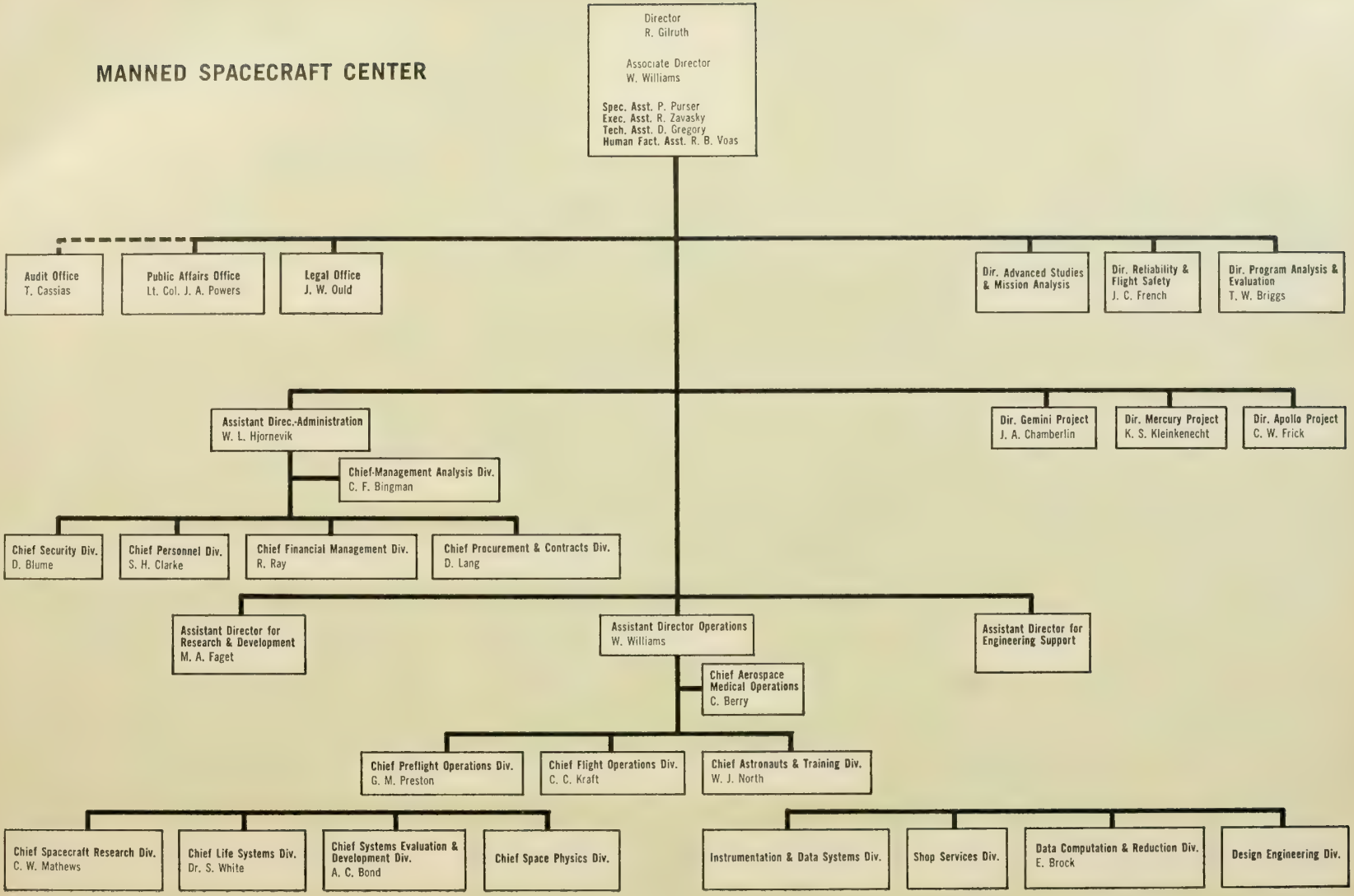


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| NUCLEAR VEH PROJ OFF | S FELLOWS |
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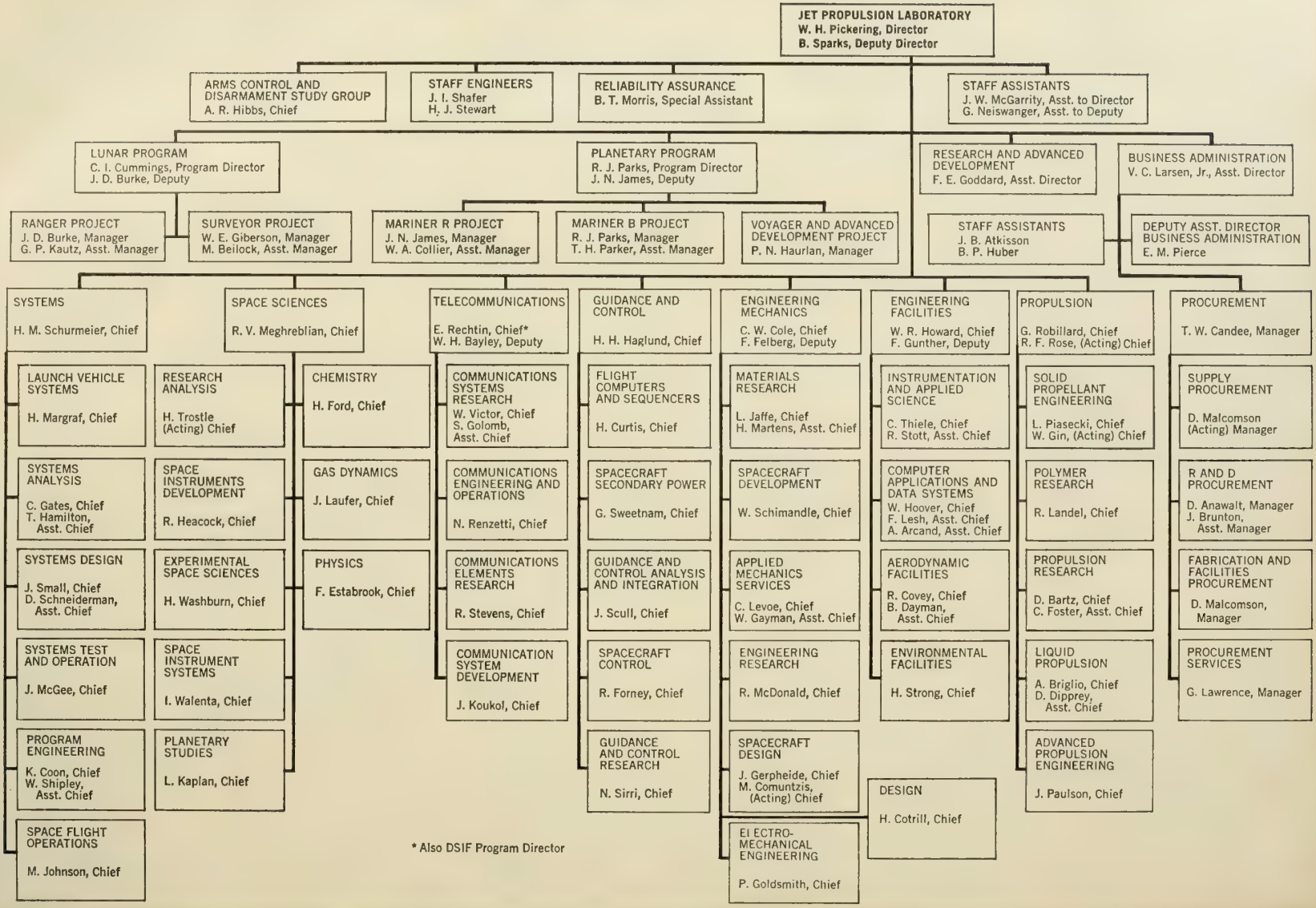
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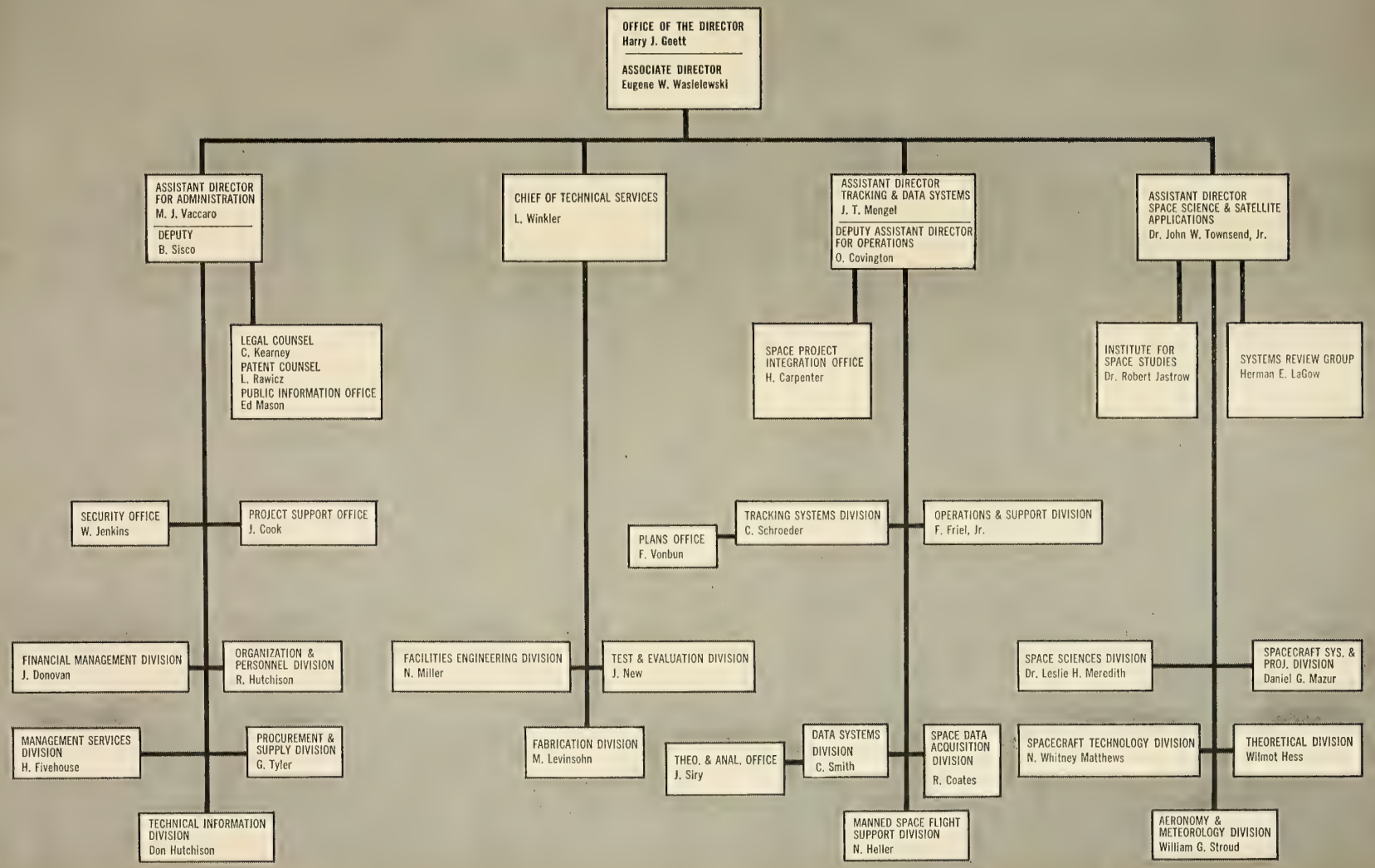
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# JET PROPULSION LABORATORY

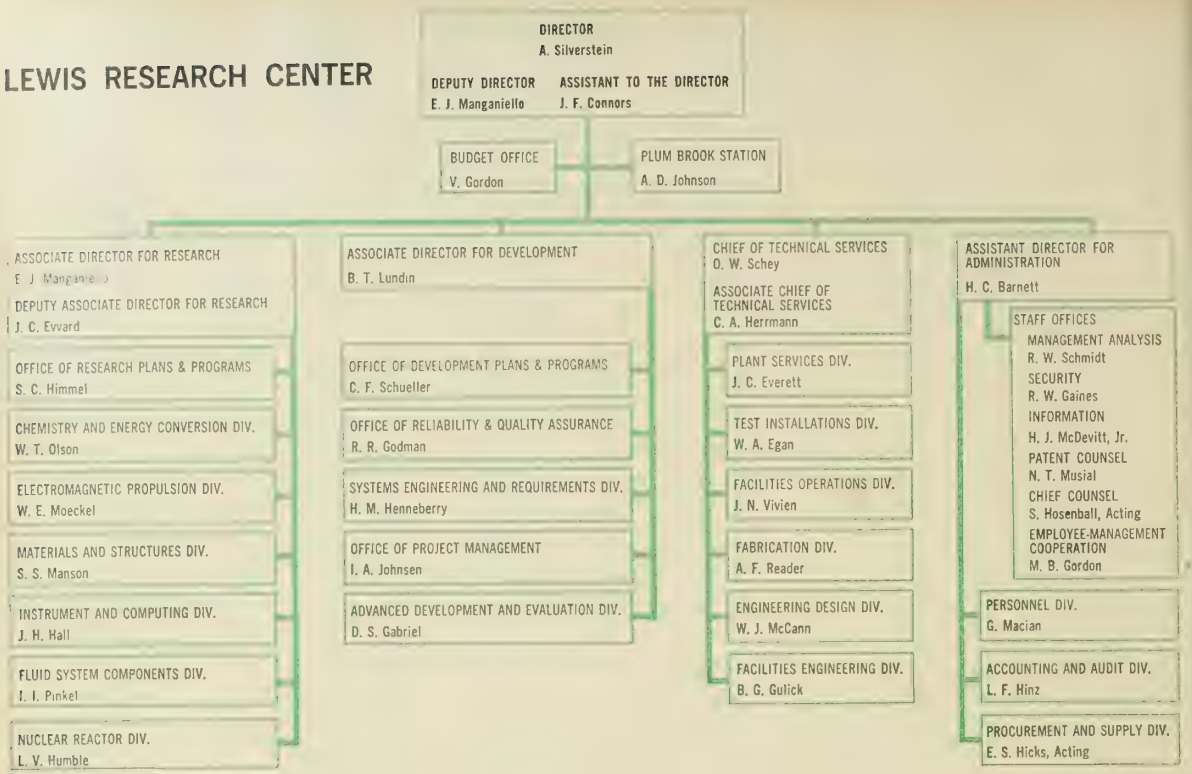



* Also DSIF Program Director

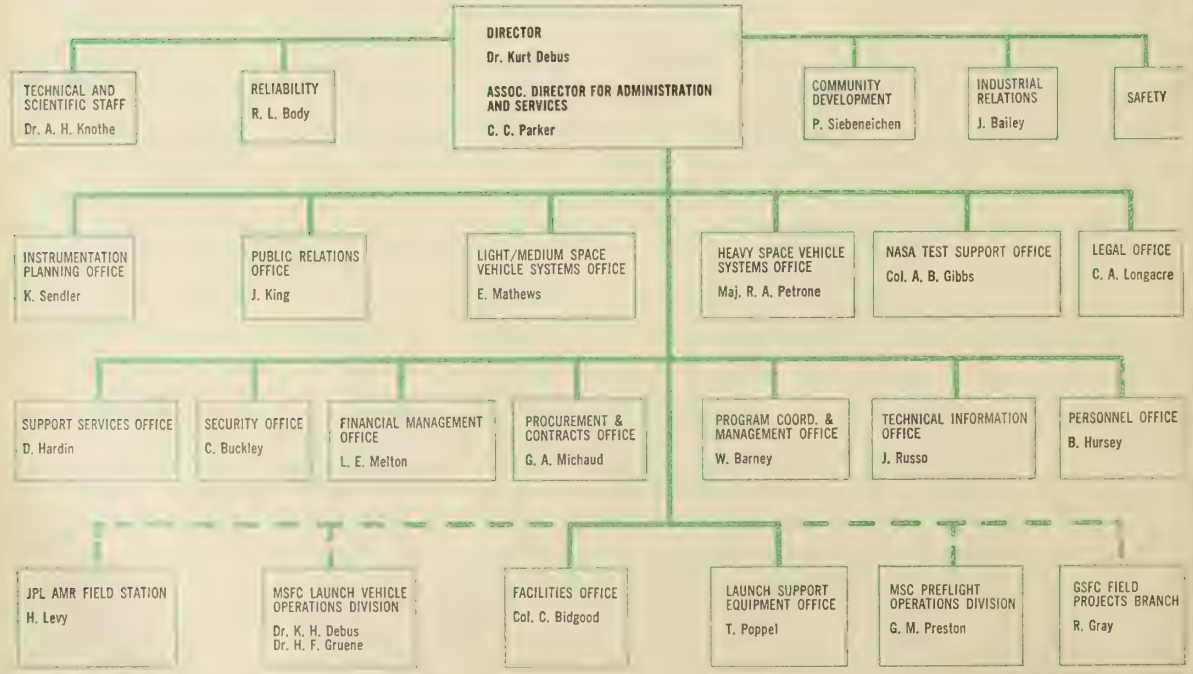
# GODDARD SPACE FLIGHT CENTER



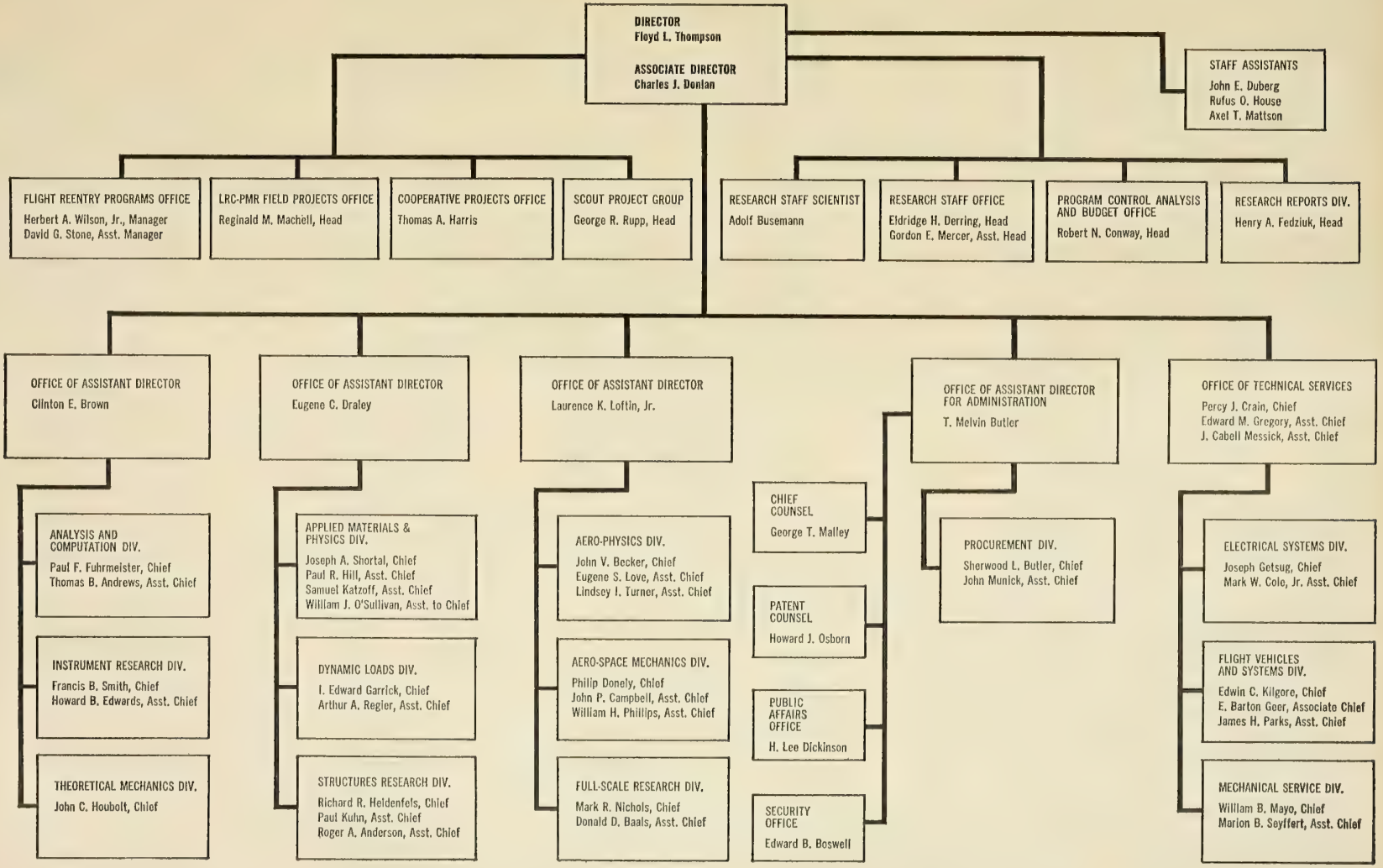
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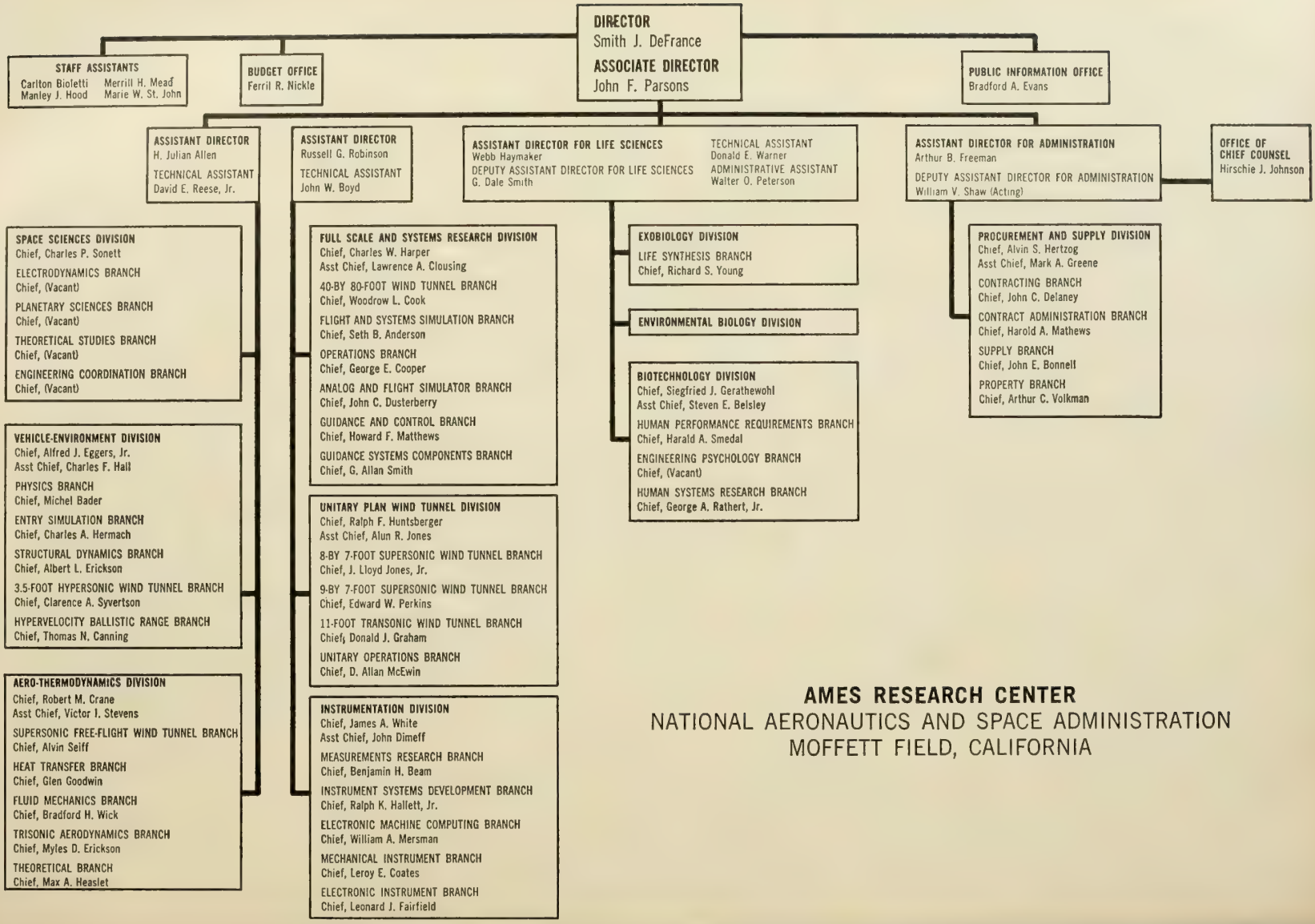



## LAUNCH OPERATIONS CENTER



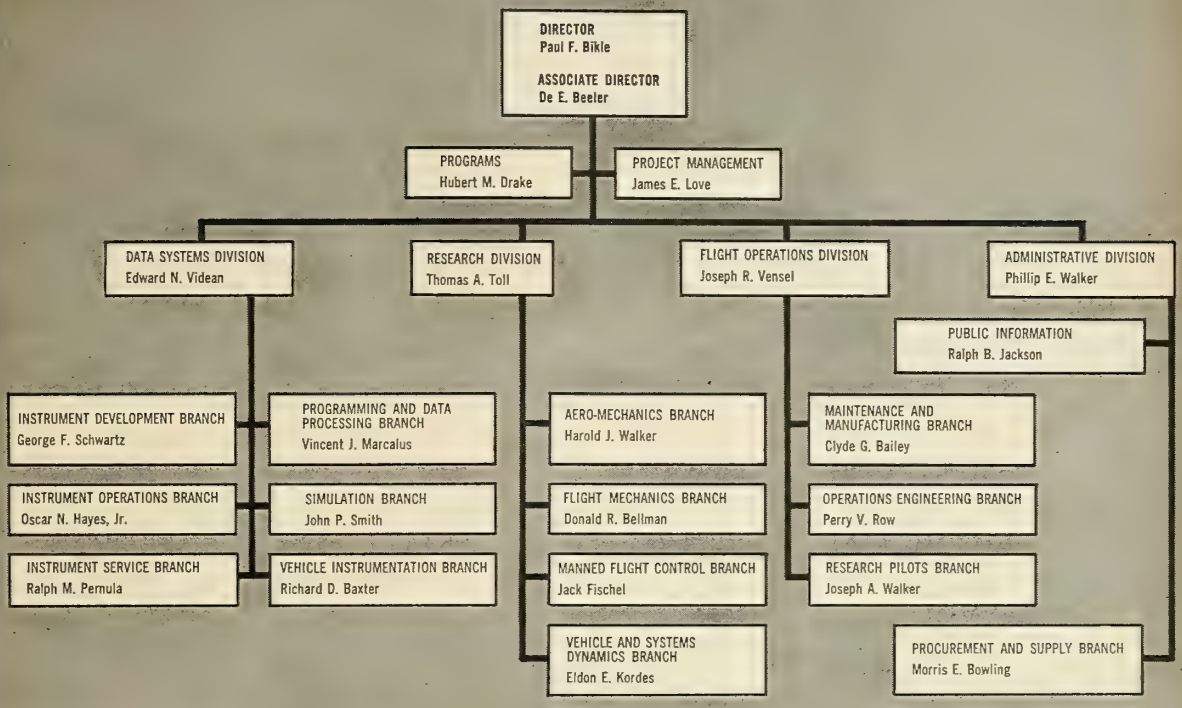
# LANGLEY RESEARCH CENTER



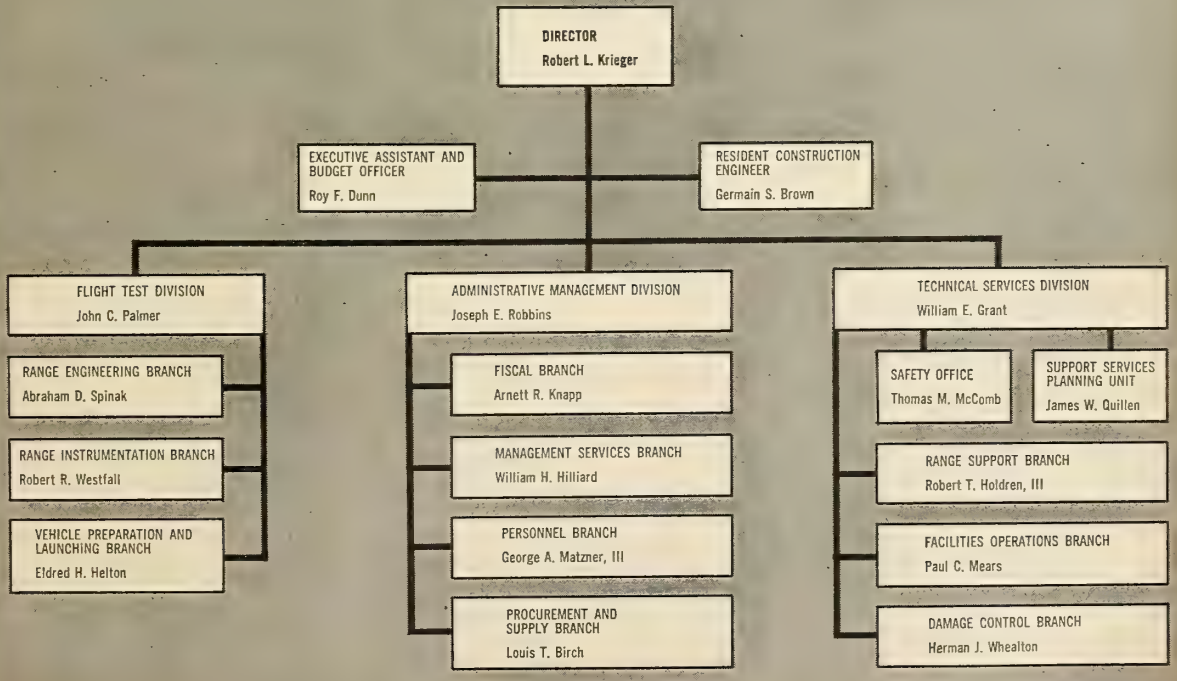



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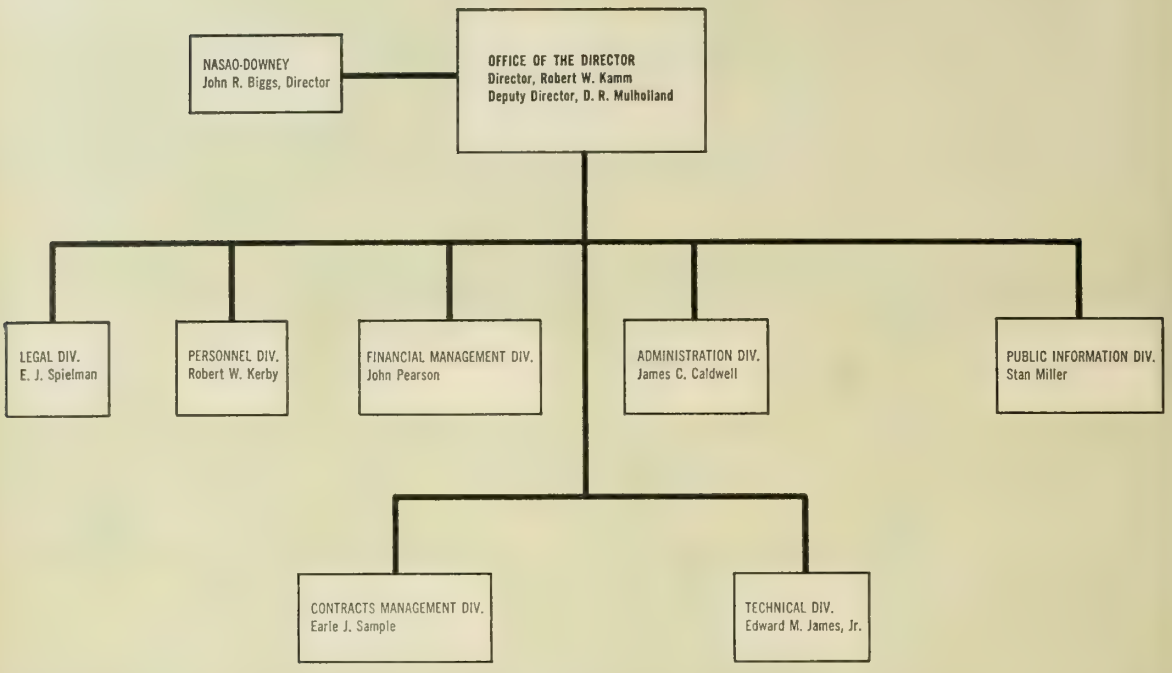
# FLIGHT RESEARCH CENTER



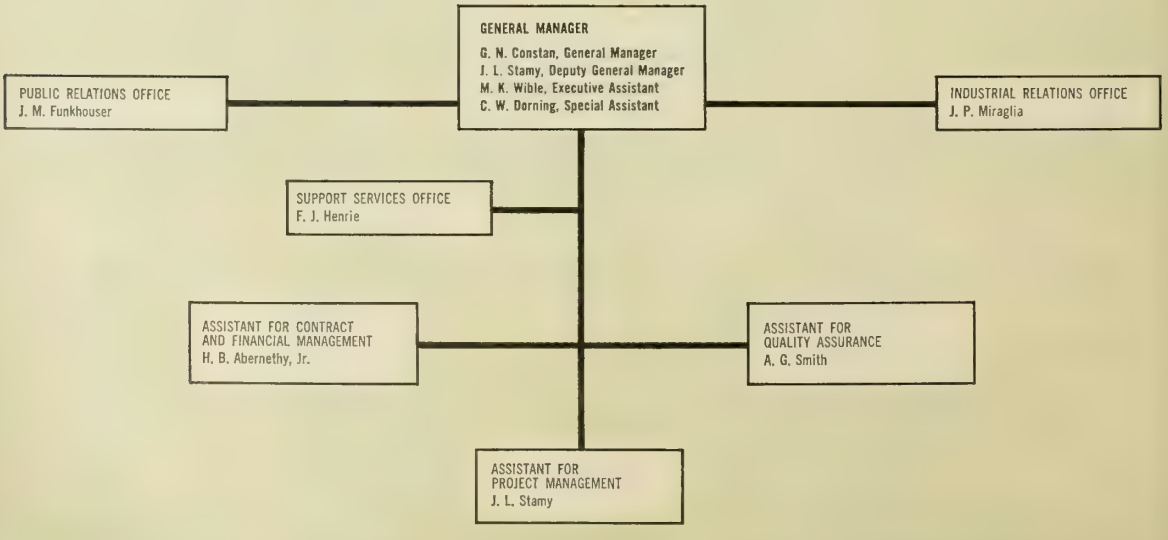

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# How Centers Will Spend $40 Billion

NASA's procurement organization will spend about $8.5 billion in the next two fiscal years.

By the end of the decade, space agency contracts will total $40 billion.

At the same time, officials at NASA headquarters, 11 field centers and two regional offices will be managing over 40 separate research and development projects in the drive to put a U.S. astronaut on the Moon and make this country pre-eminent in space.

Overall responsibility for the space program rests with the NASA headquarters staff located in Washington. It heads up a total agency work force of 23,700, including 8500 scientists and engineers.

The space agency's headquarters organizational structure was reorganized in November, 1961. Since that time, other changes have been made.

To the four program offices—Manned Space Flight, Space Sciences, Applications, and Advanced Research & Technology—has been added the Office of Tracking and Data Acquisition.

The directors of the five offices have technical and budget control over R&D projects that they assign to the various NASA field centers for execution.

Another management change was made last October to increase the authority of NASA's Moon Boss, D. Brainerd Holmes, over the manned spaceflight program in general and project *Apollo* specifically.

Holmes was elevated to the post of Deputy Associate Administrator. In the past, the three NASA centers most concerned with the manned spaceflight program—Marshall Space Flight Center, Manned Spacecraft Center and Launch Operations Center, reported to him only on the technical and budgetary aspects of their MSF operations. In the new setup, The centers report to him directly on all aspects of their operations. This is designed to give Holmes better control over the centers to insure that their facilities and personnel are used to the best possible advantage in the U.S. drive to land a man on the Moon.

The major program responsibilities of the five NASA headquarters program offices include:

Manned Space Flight—Projects *Mercury, Gemini,* and *Apollo*. Future projects which will also become part of its domain when they are approved are manned orbiting space station, lunar logistics vehicle, and manned interplanetary exploration.

Space Sciences—Its programs include earth satellites, sounding rockets, and lunar and planetary spacecraft.

Advanced Research and Technology—It is responsibile for all NASA research in the areas of space vehicles, nuclear systems, aeronautical propulsion and power generation, electronics and control and biotechnology.

Applications—This office controls the communication and weather satellite programs and is also charged with ways of making NASA-developed technology available for use by American industry. One possible future mission of the office is the establishment of a navigational satellite system.

Office of Tracking and Data Acquisition—This office directs all NASA activities in this area including *Mercury, Gemini, Apollo* and Deep Instrumentation Facility.

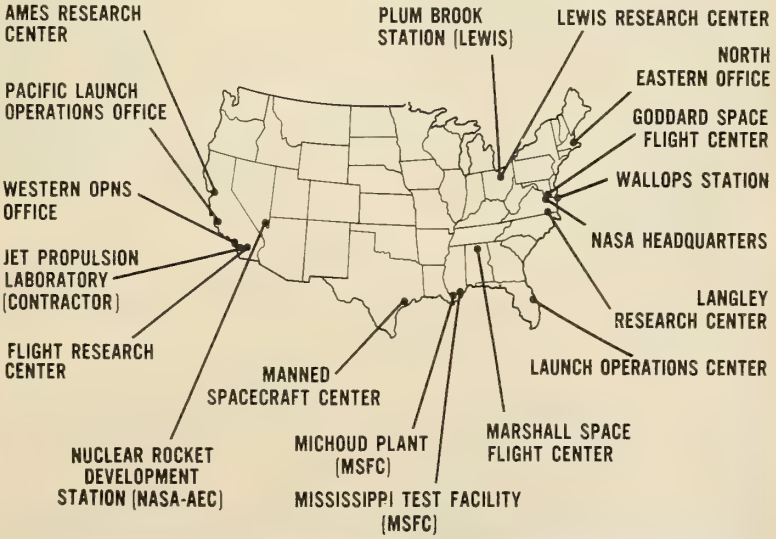
Top direction of NASA's affairs is vested in a three-man team which collectively assumes responsibility for the major technical, managerial, or contractual decisions undertaken by the space agency. James E. Webb is the Administrator of the agency and Dr. Hugh L. Dryden the Deputy Administrator. The third member is Associate Administrator Robert C. Seamans, Jr., the agency's "general manager" who sees that the entire program is implemented.

The major change has been the establishment of a new position to strengthen the flow of technical and management information beween NASA and DOD.

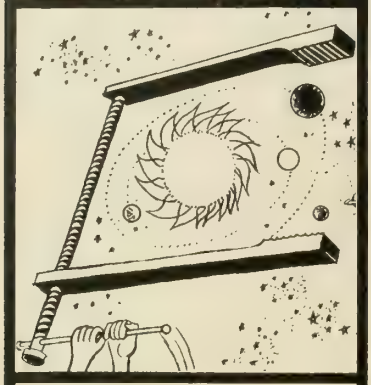
The new job has the title of Deputy Associate Administrator for Defense Affairs. It will be filled by Walter Fredrick Boone, a retired Navy Admiral.

His most important job, according to NASA officials, will be to serve as the principal point of contact between officials of both agencies. He will be responsible for promoting the most efficient use of the resources of both in the peaceful space field. He will also serve as deputy to Associate Administrator Robert C. Seamans, Jr., on the Aeronautics and Astronautics Coordinating Board which currently controls interagency space realtionships.

## NASA INSTALLATIONS



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## Marshall Space Flight Center

The Marshall Center is charged with developing and operating NASA's launch vehicles and conducting related research. The Center covers 1200 acres on the Redstone Arsenal reservation near Huntsville, Ala., together with two separate facilities—the Michoud Assembly Plant and the Mississippi Test Facility near New Orleans.

Technical functions of the Center are divided into nine laboratories staffed with 6400 people. Activities include investigations into aeroballistics and related sciences, simulation and data reduction, production of experimental-model and prototype boosters and research in manufacturing methods and technology. There is also design and pilot development of guidance and control systems and checkout and launching of boosters and space vehicles.

Typical projects include development of *Saturn* vehicles, the F-1 single-chamber 1.5 million-lb.-thrust engine, the J-2 200,000-lb.-thrust hydrogen engine, the *RL-10* and *H-1* engines. Marshall also handles the *RIFT* project for the Space Nuclear Propulsion Office.

Marshall will be the cognizant center if a decision is made to proceed with development of a *Nova*-type booster. Larger engines also may be assigned to Marshall, but NASA headquarters may have started a trend to the Lewis Research Lab in this area by switching of the *M-1* engine and *Centaur* vehicle to the Cleveland facility.

Marshall's Procurement Office, under Mr. W. Davis, placed $403,502,289 in industrial contracts during Fiscal '62. It is estimated that this will increase to about $625 million in Fiscal '63. The total will increase sharply during the next fiscal year as the *Saturn* series moves into pilot production. Marshall alone will be handling contracts of well over $1 billion.

## Manned Spacecraft Center

The Manned Spacecraft Center located in Houston, Tex., is responsible for development of the *Mercury, Gemini* and *Apollo* manned spacecraft.

Possible future programs include a manned orbiting space station and spacecraft for interplanetary flight.

For Fiscal '63, programs will have a total budget of over $600 million. In Fiscal '64, the 2000-man work force will be directing programs with a total estimated value of over $1 billion.

Another major budgetary and contracting area at MSC is construction. The comparatively new center is still in the process of building most of its major buildings and facilities. Total construction will top $200 million—with almost all of it to be completed in the next two years.

A representative list of the types of contracts awarded by the Center includes environmental test chambers, space simulators, spacecraft landing systems, analog computing systems, advanced manned spacecraft feasibility studies, spacesuits, spacecraft guidance systems, spaceflight studies, spacecraft propulsion and communication systems, liquid hydrogen densitometer, spacecraft power and spacecraft electrical systems.

MSC chief procurement officer is Dave W. Lang, Jr. Small business specialist is H. T. Christman.

## Jet Propulsion Laboratory

The Jet Propulsion Laboratory is responsible for NASA's unmanned lunar and planetary spacecraft programs.

The center, located in Pasadena, Calif., has a staff of 3800. It is operated for the space agency by the California Institute of Technology.

Its current programs have a total Fiscal '63 authoriaztion of about $239 million. This could grow to as much as $400 million in Fiscal 1964.

The programs include the *Ranger, Mariner, Surveyor* and *Voyager* spacecraft. Future projects planned by the center include Mercury and Jupiter flybys and solar and comet probes. JPL also directs NASA's deep-space tracking network consisting of stations located at Goldstone, Calif., Woomera, Australia, and Johannesburg, South Africa.

A representative list of center contracts includes spacecraft design and study, telemetry, satellite power sources, space science experiments, spacecraft design, data processing and reduction, engineering field support, equipment simulators, guidance and control equipment, launch vehicle study, component evaluation and camera and TV equipment.

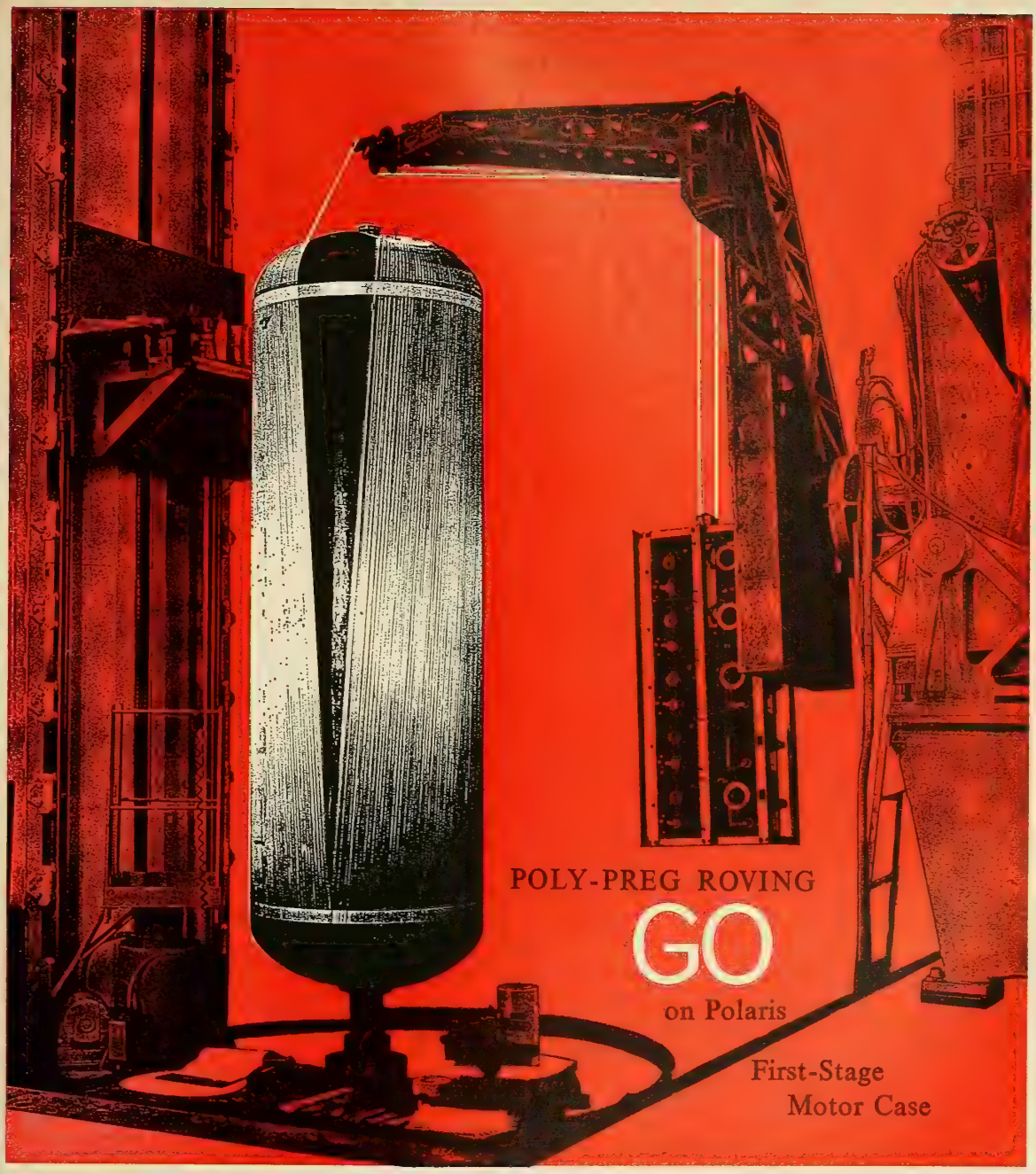
T. W. Candee directs the procurement office and Gordon Lawrence serves as small business advisor.

## Goddard Space Flight Center

The Goddard Space Flight Center, located just outside Washington in Greenbelt, Md., is responsible for NASA's Earth satellite and sounding rockets programs.

It is also the nerve center for tracking computation during all Earth satellite launchings and Project *Mercury*.

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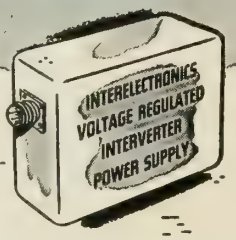
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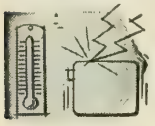
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Goddard-directed programs have a total Fiscal 1963 authorization of well over $200 million. They include all of the big orbiting observatories as well as small scientific, weather and communication satellites.

Future projects may include a new *Radio Astronomical Observatory* and monitoring satellites, as well as some solar probe work.

A representative list of Goddard contracts includes satellite power sources, satellite design, cosmic dust detection system, TV camera systems, telemetry subsystems, study of applicability of ion propulsion engines, magnetic tape, stabilization and control systems, satellite orbit studies, operation and maintenance of radio tracking facilities, electron-beam parametric preamplifiers, and fabrication of solar collectors.

Goddard also directs the work of the NASA Pacific Launch Operation Office. This handles NASA polar orbiting flights.

Director of the Goddard procurement office is Gordon H. Tyler. The small business advisor is Harry T. O'Toole.

## *Lewis Research Center*

The shift of two major programs—the M-1 hydrogen engine and the *Centaur* vehicle—to the Lewis Research Center from Marshall may indicate a greater role in the development of large rocket powerplants for the Cleveland, Ohio, facility.

As a result the budget for the center's program has jumped from $55 million in Fiscal '62 to about $200 million in Fiscal '63.

The Center has always been responsible for basic and applied research into space propulsion and power generation. Over a year ago, all electrical propulsion activity was concentrated at Lewis; one engine, an ion unit, is scheduled for flight tests next Spring.

In addition, the Center operates the Plum Brook Station at Sandusky, Ohio, site of a 60-megawatt, water-cooled nuclear reactor. Plans for a huge environmental test chamber capable of handling "hot" nuclear rocket engines are in the works, but budget considerations prevent its final design and construction.

Typical Lewis projects include high-energy propellants, zero-g effects on pumping and storage, propulsion systems for soft lunar landings, materials and heat-transfer research related to nuclear rockets, fluid mechanics and electrical power generation.

The Procurement Officer is John Biggs and the Small Business Specialist is Norman C. Prahst. Lewis has not yet completed its management organization on the M-1 program, and several studies are being made on the *Centaur*

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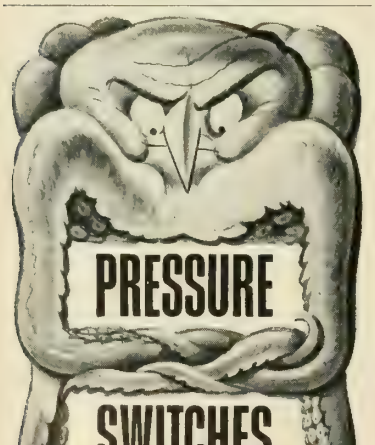
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vehicle program. Both programs should be in hand by the end of the year.

## Launch Operations

NASA's Launch Operations Center is this country's space port to the Moon and planets.

Located at Cape Canaveral, LOC's primary mission is the construction of launch pads for Project *Apollo.*

It also serves, however, as the launch site of most of NASA's unmanned scientific satellite programs as well as Projects *Mercury* and *Gemini.*

The biggest contracting item at LOC currently is the construction of the *Advanced Saturn* launch complex for the manned lunar landing program. About $400 million is allocated for the work in Fiscal '63, and construction costs are expected to rise.

Future projects will include the *Nova* launch complex as well as a site for large solid boosters when they are developed.

A representative list of contracts includes cryogenic storage and loading facilities, high-pressure pneumatic systems, sequential and metric optical systems, launcher umbilical towers, environmental control systems, closed-circuit TV systems, checkout and control systems, tracking equipment, cabling, acoustics instrumentation, mobile flame detectors, telemetry equipment, metal erosion studies, launch facility concepts for high-thrust vehicles, solid propulsion launch vehicle studies, and launch site hazard studies.

The chief procurement officer is Gerald A. Michaud. Key members of his staff include Thomas M. Davis, small business and industry advisor; Michael E. Haworth, chief, contracts branch; and George M. Lott, chief, procurement branch.

## SNPO

The Space Nuclear Propulsion Office is a joint organization set up by NASA and the Atomic Energy Commission to coordinate work on programs of interest to both agencies. In Project *Rover,* for example, AEC is responsible for reactor development and funding for nuclear aspects comes from that agency, while NASA develops the nonnuclear components and integrates the entire engine.

Funding for SNPO is at $206.2 million for Fiscal 1963, of which $156.2 million is for operating costs and $50 million for construction. By agency, the funding is $121.4 million for NASA's portion, and $84.8 million for AEC's reactor development program.

*Rover* encompasses the Kiwi series of flightless reactors, the *NERVA* (nuclear engine for rocket vehicle applications) engine, and the *RIFT* (reactor in flight test) third stage for space use. In addition to *Rover,* which is a solid-core reactor program developing propulsive force through direct heat transfer to low-molecular-weight gas, SNPO also has cognizance over *SNAP-8,* a reactor intended to develop electrical power for driving an electric-propulsion engine in space.

Headquarters of SNPO is at Germantown, Md., with extensions at Lewis Research Center, Albuquerque, N.M., and at the Nuclear Rocket Development Station (NRDS), Nev.

Typical contracts awarded by SNPO, a separate procurement office, are: Research and development to produce a nuclear-powered rocket engine including preliminary design, program planning and testing; technical assistance and consultation on engine maintenance buildings, engine test stands, nozzle test facilities, and liquid hydrogen facilities; R&D for engine development propellant-feed systems; compilation of a master plan for studying requirements of NRDS; and perform engineering studies and analysis to establish final facility design for nuclear engine test stand #2 at NRDS.

## Langley Research Center

Problems associated with space flight and planetary atmospheric entry are tackled by the Langley Research Center, Hampton, Va. This facility is responsible for development and operation of the solid-propelled *Scout* launch vehicle.

Specific space activity at the Center covers work on heat transfer, materials, structures, guidance and control of satellites and spacecraft, ballistic missiles, antimissile missiles, and boost-glide and winged re-entry space vehicles. Langley also is responsible for the *Echo* passive ComSat series and Project *Fire.*

Representative contracts include the construction of a lunar landing facility, a space vehicle rendezvous and docking simulator, *Scout* logistics support, inflatable micrometeoroid paraglider systems, feasibility studies into self-erecting manned space labs, re-entry test packages and the innumerable odds and ends associated with environmental test facilities.

Sherwood L. Butler heads the Procurement Division and Joseph F. Braig handles small business contracts. Technical officials handling inquiries are: Edwin C. Kilgore, Chief, Flight Vehicles and Systems Division; Ray W. Hooker, Chief, Research Models and Facilities Div.; and J. C. Messick, Assistant Chief Technical Services.


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NASA/Houston recently announced acceleration of its $150 million construction program. By late 1963, operations will start concentrating at the Manned Spacecraft Center and at nearby Ellington AFB. Clear Lake City bridges these two NASA nerve centers.

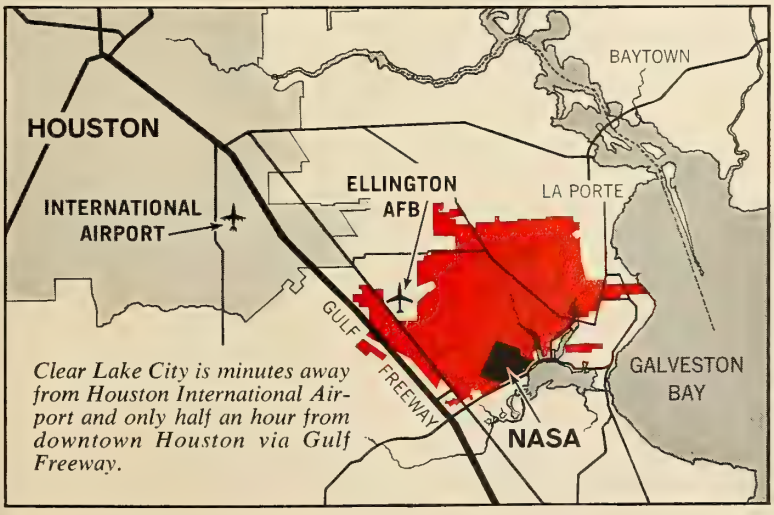
**Clear Lake City Research Park** occupies 1000 choice acres on NASA's northwest limits. The strategic location and meticulous planning of this park make it one of the most desirable R&D locations in the country. The Research Park will have extensive landscaping and underground utilities. Architectural controls will help achieve harmony without regimentation.

The Industrial Park, with identical improvements and controls, will adjoin the Research Park on the south. An Industrial District will be located in the northwest.

**First class office space** suited to technical representatives will be ready for occupancy next spring.

Clear Lake City will boast a fine motor hotel, apartment buildings, mobile home park, community center, shopping center, model homes and country club. The first nine holes of an 18-hole, four-season golf course will be playable in 1963.

Northeast of Clear Lake City, 7000 acres are to be developed for heavy industry by Humble Oil & Refining Company.




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**For detailed information,** write or call W. Lawrence Prehn, Jr., Resident Manager, Commercial and Industrial Development, Del E. Webb Corporation, 900 Texas National Bank Building, Houston 2, Texas. Telephone CApitol 8-0781. Your inquiry will be treated in the strictest confidence.

*Clear Lake City is a project of Del E. Webb Corporation for Friendswood Development Company.*

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## Ames Research Center

Manned satellite re-entry, boost-glide vehicles, proposed manned interplanetary and lunar craft, ballistic missiles and life support systems are concentrated at the Ames Research Center, Moffett Field, Calif.

About 66% of the Center's programs are space-related, and include a wide variety of environmental studies and the development of highly specialized simulation apparatus, as well as both basic and applied research in stabilization and guidance.

Ames' Life Sciences Group works in areas untouched by other U.S. researchers—such fields as exobiology or extraterrestrial life and life synthesis, environmental biology and the application of biological data to engineering problems and systems.

Specific contract areas include the psychophysiology of stress, motivation and learning; fundamental studies of fluid mechanics and elastic behavior of the vascular system, including acceleration effects; radiation measurements of the radiobiological hazards to man in space; sensory testing; high-altitude balloon flights; tactal sensing systems; solar-probe attitude-control studies; solar-cell calibration and an all-attitude inertial reference system.

The Procurement Officer is A. S. Hertzog. Donald E. Davis functions as the small business specialist.

## Flight Research Center

The Flight Research Center, located at Edwards, Calif., is responsible for *X-15* rocket plane and other high-speed flight programs.

As a result, it will also have management responsibility of NASA's portion of the Air Force *Dyna-Soar* program. Further in the future, it will probably direct the aerospace or hypersonic plane research programs.

FRC is one of the space agency's smaller field centers. It has a staff of 330.

Chief procurement official is Morris E. Bowling, Lloyd J. Walsh is the small business specialist.

## Wallops Station

NASA's Wallops Station is the space agency's headquarters for *Scout* booster launches and its sounding rocket program.

Payloads include re-entry of space flight models, models on manned space flight capsules, ionized layer data-gathering and other sounding devices.

Some 200 research vehicles are launched each year.

Wallops is also the prime tracking and command station for the *Tiros* weather satellite program.

Procurement officer is Louis T. Birch. Robert H. Bradfors is the small business advisor.

## Western Operations

All liaison responsibility covering NASA contract activities west of Denver is handled by the Western Operations Office, Santa Monica, Calif. Besides general administrative support of the various agency offices, Western Ops handles specific assignments from NASA Centers, assisting them in monitoring their contracts with West Coast firms.

In some cases, Western Ops may be asked to oversee the reliability and inspection aspects of a contract—or a center may seek continuous technical liaison with an on-the-spot project engineer.

In other instances, the business office of Headquarters or a Center may have Western Ops pay contract bills in the area, ask for security services in contractor's plants, or provide legal and patent services.

Director R. W. Kamm and his staff work closely with the directors of the four Headquarters Program Offices and NASA Center chiefs. In Fiscal '62, Western Ops negotiated, awarded or administered contracts totalling $267,541,000 in behalf of the rest of the space agency.

Chief contracting officer and head of the Contract Management Div. at Western Ops is Earle J. Sample, Jr. Paul E. Ross is the deputy chief.

A field contract administration post is in operation at North American Aviation's Space and Information Systems Div. Called the NASA Office-Downey, the unit is analogous to a DOD Plant Representative and represents NASA's first attempt to coordinate its business and technical activity at a contractor facility.

## Northeastern Office

The recently established Northeastern Office eventually will perform technical liaison and contract administration in the New England area.

Currently, the office located in Boston, Mass., is charged with developing cooperative relationships with various universities in the New England area as well as with the burgeoning group of industries in that region concerned with aerospace matters.

Since its establishment, earlier this year, the office has acquired a staff of 30, but has still not set up its organizational structure. Director is Franklyn Phillips.

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- **GMRD** and its subcontractors operate and service the tracking and other electronic equipment of the range.

In addition, PAN AM provides launch and operations support at Cape Canaveral and Down Range.

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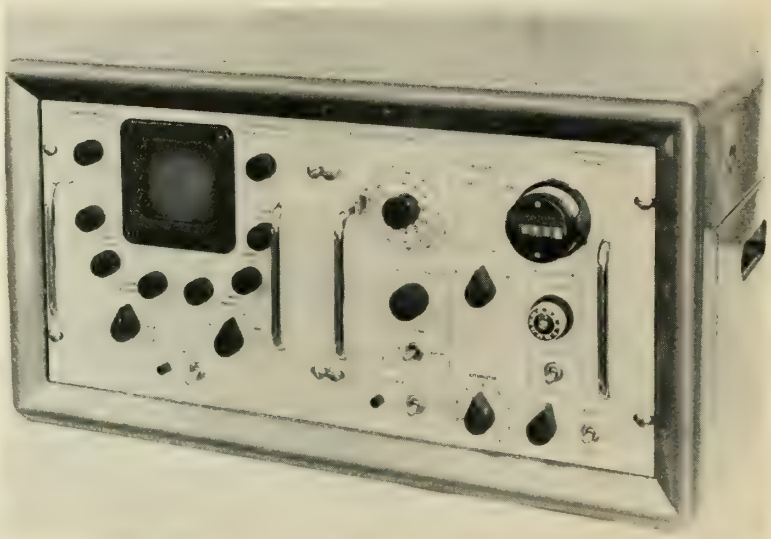
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## *New Product of the Week:*

### *Cryogenic Bridge*

Cryotronics, Inc. subsidiary of Malaker Laboratories, Inc. is marketing an a-c resistance bridge (Model ML 155-AC)—designed to provide an accurate means of measuring values of unknown resistance—utilizing very low power on the order of 1 microwatt or less.

The bridge is designed for use in the cryogenic thermometry field, where resistances are used as temperature transducers. Temperature range is limited only by the type of transducer used. As the bridge is highly sensitive, it is possible to make high-precision measurements using extremely low power dissipation in the unknown resistance.

Circle No. 225 on Subscriber Service Card

### Filter System

A dynamic tracking filter system developed by Spectral Dynamics Corp. is comprised of an SD-1010 tracking signal generator that can drive as many as four specially developed SD-1012 two-channel tracking filter slaves. Thus, a single system can provide for simultaneous analysis of up to eight channels of real-time information.

The driver and the required number of slaves can be housed independently of each other, or a complete eight-channel system can be incorporated in only 35-in. of space in a standard rack.

Tubing signal frequency range of the tracking filter system is 2 cps to 25 kc in one range, and dynamic range of the SD-1012 is 60 db for filtered signal output.

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### Expansion Gage

Statham Instruments offers Model MD-1, an instrument to determine the thermal coefficient of expansion of materials.

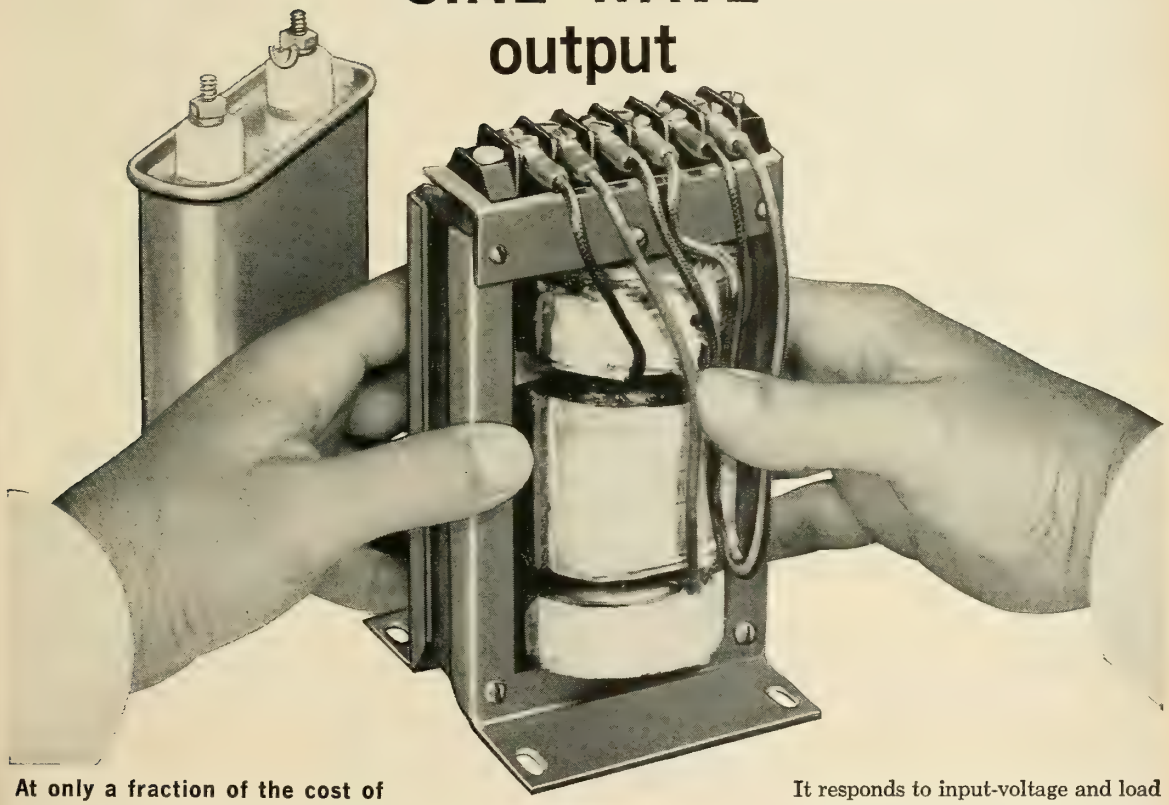
Portable and battery powered, the MD-1 meter is designed for use in both the field and in the laboratory. It can read either the expansion or contraction of a sample of a given material. A direct readout in microinches per inch is provided when the multi-turn potentiometer is adjusted to null the indicator.



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# new!

# 400 cycle constant-voltage transformer with SINE WAVE output



120 VA 400-CYCLE CVS
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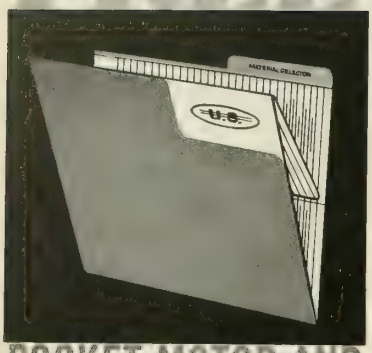
**At only a fraction of the cost of magnetic amplifiers** this all-new Sola 400-cycle CVS transformer provides constant-voltage sine-wave output, with *maximum 3% total rms harmonic content!* Output suitable for air-ground support equipment, missile test and operating gear, computers, data processors, communications equipment, and inverters. Simplicity of circuit makes the CVS remarkably rugged and reliable. 400-cycle constant-voltage CVS circuit automatically insures continuous, close-tolerance voltage regulation — without sensing devices or a d-c power supply. It responds to input-voltage and load fluctuations far more rapidly than a magnetic amplifier. Also reduces physical requirements, with weight only one-third that of comparable 60-cycle units. New 400-cycle CVS transformers are available now, from stock, through Sola "Regulation Headquarters" in 60 to 1000 va range; epoxy encapsulation *optional*. "Specials" also readily made to your requirements or to military specifications. 115-v nominal input (95 to 130 v); 118-v regulated output ±1%; load regulation ±1%, full load to no load. Write us for full details and prices.

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## Cryogenic Valves

B. H. Hadley, Inc., is marketing the "CHV Series" line of cryogenic shutoff valves.

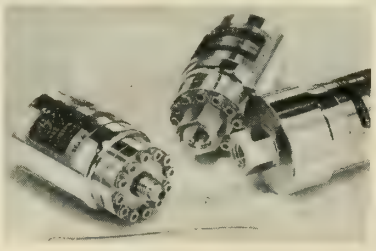
The 300# Series, like the 150# class, provides relatively Zero leakage down through liquid hydrogen temperatures. Features include the Hadley developed "Thermetic Seal," compact size, rugged reliability and long service life with proven performance in test and ground handling of $LH_2$, $LN_2$ and LOX.

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## High-Power Modulator

The high-power oscillator PG-650-C produced by the Arenberg Ultrasonic Laboratory has been modified to perform as a gater modulator as well as a gater amplifier over its extensive range from 300 kc to 100 mc. Performance is obtainable from two or three push-pull stages with an optional suppressed carrier mode. CW input signals from 1-10 volts from a high impedance source will give outputs of 40-100 watts pulsed output. Background CW leakage is 80-100 db below pulsed output. Bandwidths of 10% of the carrier may be obtained allowing for FM as well as audio modulation. Pulse lengths of 1½ to 20 μsec are available at PRF from 50 to over 3000 on standard units.

Besides numerous applications in electronic testing, the instrument is designed for ultrasonic research involving measurements of absorption and velocity in small samples. The long pulse or interferometer technique requires determination of the difference in frequency between resonances. By setting the carrier (suppressed or not) at a peak, the frequency of the gated modulation will give the difference frequency directly and accurately.



Circle No. 229 on Subscriber Service Card

## Capacitor Analyzer

A capacitor analyzer that tests units with voltage ratings of one to 500 volts has been developed by Cornell-Dubilier Electronics Div., Federal Pacific Electric Co. Model BF-71 measures capacitance without causing damage to capacitors or change in their characteristics.



The BF-71 operates on 115 volts, 50/60 cps and measures capacitors with values ranging from 10 mmfd to 2000 mfd. Its resistance measurement range is 2.5 ohms to 25 megohms; and its current measurement range is 2 microamperes to 100 milliamperes. These measurements, including voltages from 0 to 500 volts, are all within 3% accuracy (sensitivity is 10,000 ohms per volt). The analyzer is also capable of measuring power factors up to 50 percent.

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## Portable Communicator

Raytheon Co. has developed a portable communicator that uses a pencil-thin infrared beam to set up the long-distance "private line." The device can solve communication problems at missile sites, blasting sites, and airfields.

Messages are of crisp, radio quality. A built-in speaker also serves as microphone. Even when users are 2 to 3 ft. from the set, the voice is heard loud and clear.

The IR communicator can be used day or night in all climates. It operates in temperatures ranging from zero to 130° F.

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## Etch Resist Spinner

Transmask Corp. has deveolped an etch resist spinner for applying even chemical etch resist coatings upon silicon wafers.

Rapid acceleration to operating speed is the outstanding feature of this new machine. Acceleration from stop to full speed is accomplished in less than one second as compared with conventional equipment requiring 20-30 sec. Rotational speeds may be set from 6000 to 12,000 RPM.

This unit provides a high-speed vacuum chuck to hold and spin the semiconductor wafer, a vacuum pencil to handle parts, and a built-in vacuum pump.

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For as long as four days, the two astronauts will explore the moon —one of man's most incredible scientific opportunities—using the "moon bug" as home base. Then they will rendezvous with the mother ship, in which a third astronaut will have been circling the moon. They will re-enter the Apollo command module, jettison the "moon bug" and head for Earth.

It will happen before this decade is over.

This venture and NASA's many other advanced projects require scientists and engineers with the highest qualifications. If you are interested in employment with NASA, please send a resume to Personnel Officer of: NASA Headquarters (BPH), Washington 25, D. C.; NASA Goddard Space Flight Center, Greenbelt, Md.; NASA Langley Research Center, Hampton, Va.; NASA Lewis Research Center, Cleveland, Ohio; NASA Marshall Space Flight Center, Huntsville, Ala.; NASA Ames Research Center, Mountain View, Calif.; NASA Flight Research Center, Edwards, Calif.; NASA Manned Space Craft Center, Houston, Texas; NASA Launch Operations Center, Cocoa Beach, Florida.

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"Linearchek" is a lightweight, portable hand-size unit providing a convenient, fast and accurate means for checking linearity of single and multiple dimension gaging fixtures using dial indicators, air or electronic gaging cartridges or combinations thereof. It can be used in the shop, gage lab or receiving and inspection.

The instrument uses a Sheffield Ultra-Precise Micrometer, guaranteed accurate to ±10 millionths of an inch per inch, to determine linearity. The micrometer has a one-inch range and a four inch diameter barrel with reading to 10 millionths of an inch by vernier scale. Its gaging anvil rotates. A rotating thimble is provided on the micrometer to facilitate zeroing it with the indicating system of the gage to be inspected.

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## Stud-base Rectifiers

A line of low-priced stud-base rectifiers has been developed by the Delco Radio Div., General Motors.

The 1N3208 to 1N3212 series has a basic current rating averaging 15 amps over a temperature range of −65°C to 150°C. The rectifiers maintain full rated reverse voltage capability to 175°C which extends through the forward current derating range of 150°C to 175°C.

Maximum peak reverse voltage ratings are available from 50v to 400v. Maximum RMS voltages in the series are from 35v to 280v. Top d-c blocking voltages range from 50v to 400v. The units withstand peak one-cycle surge current of 250 amps at 150°C case temperature. The new rectifiers are available with either cathode or anode connected to base, the latter designated by R suffix.

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## Bandswitching Discriminator

Available from Airpax Electronics, Model FDS4 bandswitching discriminator is a high-accuracy demodulator of frequency modulated telemetry subcarrier signals having IRIG or similar characteristics. Special features include a precision carrier voltmeter, precision offset adjustment, continuously variable gain control, output of ±10 volts at ±100 MA, carrier failure warning, ready access to all measuring points, and completely modular construction.

The input sensitivtiy, 10 millivolts to 10 volts RMS; static linearity, ±0.1%; output, 0 to ±10 volts, 0 to ±100 milliamperes, ±ampere available; output noise, at least 60 db below peak



output for all channels; output stability, less than 0.3% of bandwidth after 15 min. warmup; power requirement, 45 watts, 105 to 125 volts RMS, 50 to 60 CPS.

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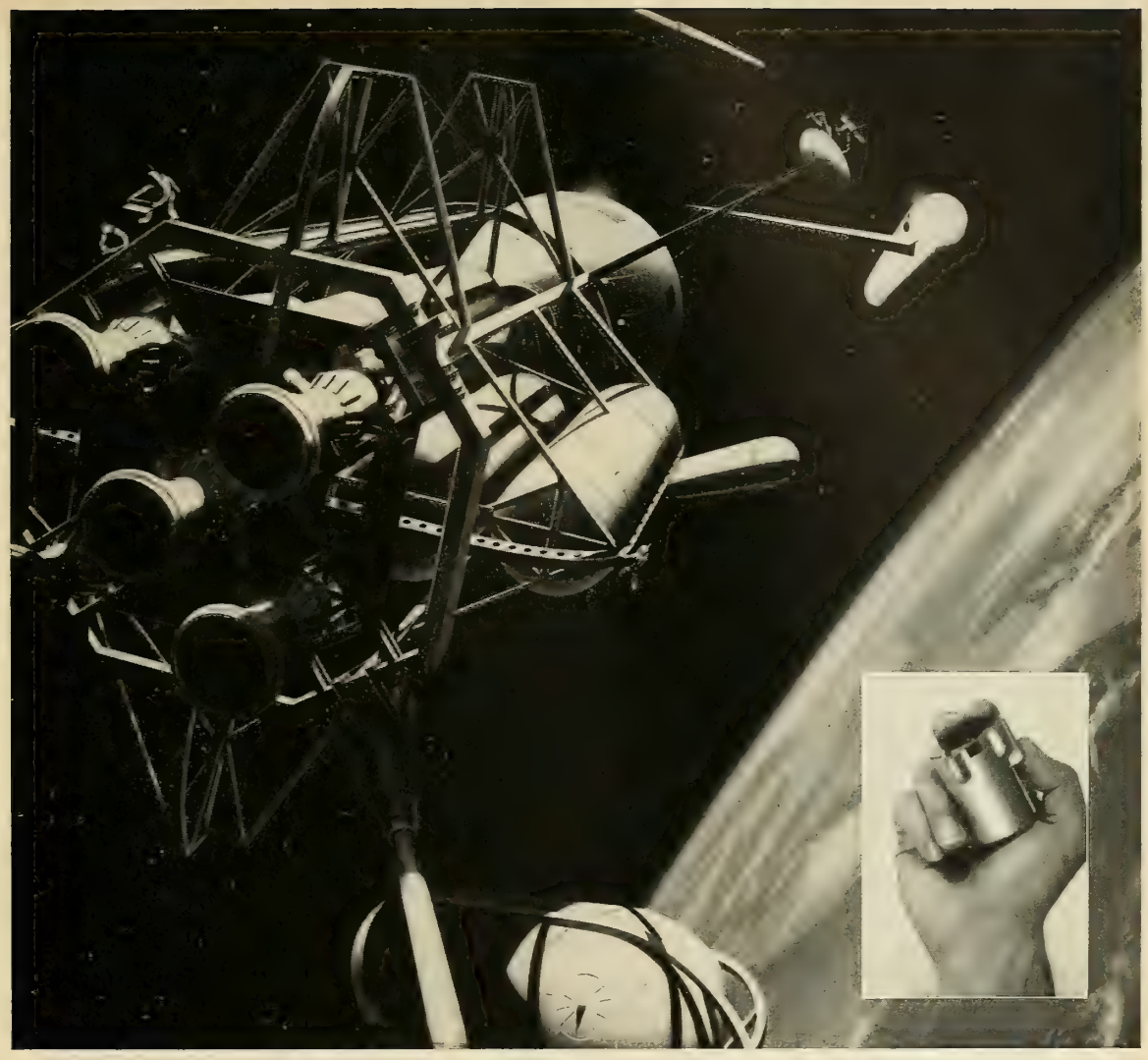
*U.S. Pat. Nos. 2,626,841; 2,724,172; 2,728,975. Others applied for.

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# Project Cap Pistol

"Cap Pistol", a subminiature rocket motor, is as simple as its namesake in concept — and even smaller in size. Developed for the US Air Force by the Wright Aeronautical Division of Curtiss-Wright, it is a space vehicle control system designed to guide spacecraft precisely on-course during flights outside the earth's atmosphere.

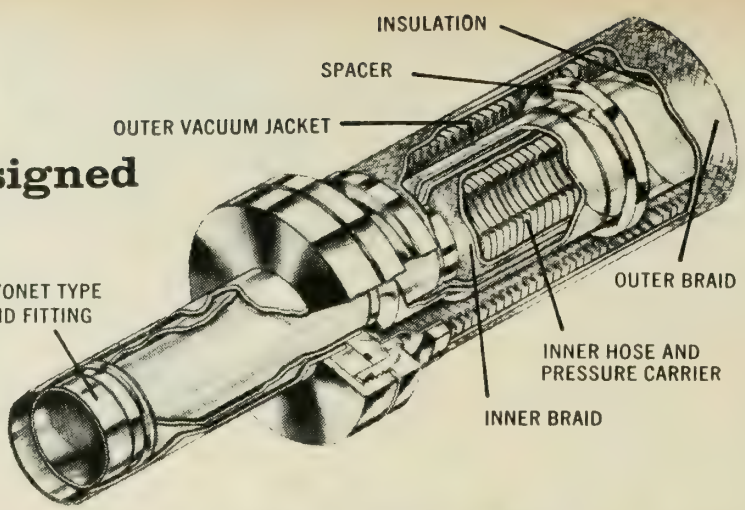
Cap Pistol fires bits of solid propellant, each an individual rocket motor, to make possible controlled pitch, yaw, and roll in outer space—where the mere force of a whisper can maneuver a multi-ton spacecraft.

A new concept in rocket propulsion systems, Cap Pistol is by far the most reliable yet devised for a variety of space applications. Cap Pistol can be stored anywhere in a space vehicle without regard to pressurization or time lapse—and offers a sure-fire ignition capability for days, months, *years*.

**Cap Pistol** is one of a series of advanced rocket engine projects being conducted by the Wright Aeronautical Division today, for the spacecraft of tomorrow. Information is available on request.

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## about products, capabilities, and literature in this issue

- Circle the appropriate numbers on the card.
- Fill out the card completely . . . title and company are a MUST.
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# Collins communications careers point UP

Every American voice from space — from the X-15 and Mercury — has been carried by Collins communications. Now, with the accent on reliability, Collins is readying extensive systems for the next and most ambitious U.S. space effort, NASA's Apollo manned lunar spacecraft. ☐ To further extend this leadership in space communications, Collins requires specialists in HF, VHF, UHF equipment, digital communications, spacecraft antennas, TV, radar, modulation techniques, tracking and ranging, information theory, and ground systems. If you are the E.E., M.E., Mathematician, or Physicist who can grow with these projects, write Mr. L. R. Nuss, Collins Radio Company, Dept.MR, Cedar Rapids, Iowa.



high temperature valve

OPERATES AT 1500°F

(— and modified, up to 2200° F.)

for handling metal vapors, molten metals, hot gases and fuels—

A few short years ago 900° F. was considered "high" temperature. Since then the needs of the aero-space and nuclear industries have pushed the "limits" steadily upwards.

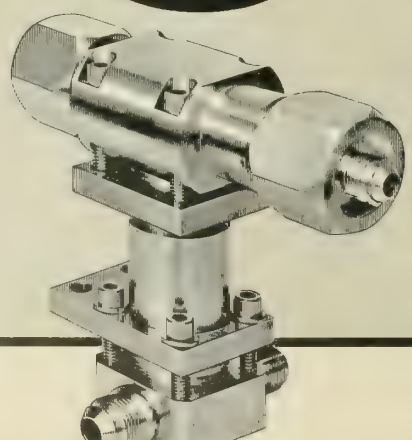
Valcor's technological growth, over the years, has allowed it to transcend these frontiers.

Series 420 is the result. This is not a theoretical or "paper" design. These are production valves. As illustrated, it is used by industry for 1500° F. applications. In a modified form it is being used for 2200° F. service.

Series 420 can be actuated directly or remotely—pneumatically, electrically or manually. It is a floating shear seal type of valve with straight through flow which can be modulated.

For complete details on this and other valve series, write today for Catalog M 109.

VALCOR SOLENOID VALVES



VALCOR ENGINEERING CORP.

5362 CARNEGIE AVE., KENILWORTH, N. J., CH 5-1665 (AREA CODE 201)

Circle No. 106 on Subscriber Service Card


## Multi-Throw Switch

American Electronic Laboratories, Inc., has developed a coaxial, multi-throw switch useful for broadband operation over the range of 0.3 to 7 gc, and available in SP4T and SPDT models with characteristics comparable to those of SPST units.

Insertion losses are as low as 1.2 db and isolation as great as 43 db in portions of the band. Switching speed is in the nanosecond range.

Circle No. 236 on Subscriber Service Card

## Transducer

A high-performance digital-output pressure transducer is available from Statham Instruments, Inc. The Model P606 converts pressure into a 7-bit unambiguous binary code output that divides the pressure into 128 discrete parts. Output can be read visually or can be fed directly into a magnetic tape system, typwriter system, etc.

The unit pressure measures are from 0-1 psi through 0-1000 psi FS; absolute, gage and differential. Combined non-linearity and hysteresis is less than ±1%FS. Input is 1 to 10 volts; output is a 7-bit binary code, 1 to 10 volts. The instrument operates over a temperature range of −65°F to 250°F. Thermal zero and sensitivity shift is less than 0.01%FS/°F.

Circle No. 237 on Subscriber Service Card

## Low-Level Amplifier

The Redcor Model 361 offered by Redcor Corp., is designed for data acquisition and other systems.

This self-powered unit is a completely solid-state d-c amplifier that includes choppers. Bandwidth is unaffected by gain change, and the common mode rejection ratio increases in direct proportion to an increase in amplifier gain.

Specifications of Model 361 include: gain accuracy of 10 to 1000, ±0.02%; gain linearity of 10 to 1000, ±0.01%; input impedance of 1000 meg; drift of ±3x gain ±300 uvolts; noise of 10 uv rms at 100 KC, 20 uv p-p at 1 KC and 4 uv p-p at 30 cps; settling time of 20 usec to 0.01% and common mode rejection of 120 db dc-150 cps.

Circle No. 238 on Subscriber Service Card

## Waveguide Switch

Waveguide, Inc., is marketing a C-band switch incorporating a cocking mechanism that will switch parts in a total time of only 30 milliseconds and requires no holding current.

The switch, a single-pole double-throw or four-part transfer type, uses a motor drive to cock a drive spring while the rotor is latched prior to receiving a switching signal. When a switch pulse is received, the latch releases the rotor and it is moved to the new position by spring action. Switching time is 12 milliseconds for rotor travel—30 milliseconds total reaction time.

Circle No. 239 on Subscriber Service Card

## Wire Stripper

A Thermal wire stripper available from Sentry Electronics, Inc., eliminates nicking of wire during stripping operations. The specially designed heating element melts the wire covering and anneals the inner copper wire, making it more flexible and eliminating wire breakage.

Variable temperatures are provided for Teflon, Formvar, Nyclad, Vinyl and other plastic coverings. Length of the wire to be stripped can also be regulated for production stripping.

Circle No. 240 on Subscriber Service Card



# RAYTHEON will build APOLLO Guidance Computer

NASA has selected Raytheon's Missile and Space Division to produce the digital guidance computer for the APOLLO manned lunar exploration program. This computer, located in the spacecraft, will serve as the mission nerve center during the entire APOLLO flight. It will receive the outputs of each of the guidance system's sensors.

Data will be processed by the computer for automatic control of certain flight functions and for presentation to the crew to permit the optimum exercise of human intelligence during the mission. The computer will be used for all phases of the APOLLO mission.

Under its NASA contract, Raytheon will provide engineering support on the computer design to the M.I.T. Instrumentation Laboratory, which has design responsibility for the complete APOLLO guidance system. In addition, Raytheon will produce the computers which will be used on APOLLO flights.

The selection of Raytheon for this key role in the APOLLO program is but one indication of Raytheon's rapidly expanding space program and demonstrates that in the space age, as in the past, Raytheon means Excellence in Electronics.

Engineers or scientists interested in a challenging career in Raytheon's space and missile programs are invited to contact Mr. W. F. O'Melia, Raytheon Company, Missile and Space Division, Bedford, Massachusetts.

RAYTHEON

# SOLID PROPELLANTS
# GAS GENERATORS
# ROCKET MOTORS
# BALLISTIC DEVICES

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| **Ammonium Nitrates**<br>**Polysulfide/Perchlorates**<br>**Plastisol/Perchlorates**<br>**PBAA Perchlorates** | **Linear Actuators**<br>**Rotary Actuators**<br>**Rocket Catapults**<br>**Explosive Fasteners** |
| Low Flame Temperature, slow burn rates, smokeless, and castable are features of our ammonium nitrates. High energy, fast burn rates and castable are features of our perchlorates. All propellants have been tested from —65°F to 160°F. Some have been tested to 200°F. | Actuators with strokes of fractions of an inch to 9 feet or more and thrusts from several to several hundred thousand pounds. Gas generators with burning times up to 5 minutes. Separation devices contain all gases and have no fragmentation. |

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These and other features of our small, fast growing company have, within the past three years, resulted in our products being used on the following major weapon and space systems:

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| **MINUTEMAN** | **B58** | **T33** | **F5A** |
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We have complete facilities for research, development, testing and production of propellants and devices.

For detailed information write or call:

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Field Engineers in: Los Angeles, Seattle, Dayton and Washington, D. C.

Immediate openings exist for qualified engineers and scientists. Call or send resume to: G. E. Hirt, President.

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Circle No. 107 on Subscriber Service Card


## Measuring System

An electronic measuring system which combines the capabilities of many separate laboratory instruments is available from Technitron, Inc.

The Technitron 990 consists of a basic indicator-amplifier unit, a series of plug-in circuit modules and several probes permitting a variety of electrical quantities to be measured in one system.

Voltage measurements in 23 ranges from a 5-mv minimum to a 30-kv maximum and input resistance of 100 teraohms with 1 percent FSD accuracy are provided. The system also allows d-c current readings from 10 picoamps to three amps in 21 ranges. Resistance measurements are from 1 ohm to 100 megohms mid-scale, and 10 kilohms to 10,000 megohms FSD.

Circle No. 241 on Subscriber Service Card

## Ultra-High Vacuum Chamber

The CVU-18 ultra-high vacuum chamber is available from Consolidated Vacuum Corp. With an ultimate vacuum of $5 \times 10^{-10}$ torr, the unit is useful for space simulation, vapor deposition, materials analysis, solid-state research and a variety of other applications. It attains a vacuum of $2 \times 10^{-9}$ torr approximately four hours after bakeout.

The CVU-18 approach combines chamber bakeout, baked sorbent trapping, water-cooled baffling and diffusion pumping. The sorbent material, Zeolite, can easily by replaced or regenerated, without need of a liquid nitrogen supply or other cryogenic equipment.

Circle No. 242 on Subscriber Service Card

## Accelerometer

A tri-axis strain gage accelerometer which measures acceleration along three mutually perpendicular axes is marketed by Consolidated Electrodynamics Corp.

Acceleration ranges available are from ±5 g's to ±500 g's. Cross-axis response is less than 0.01 g per g for ranges through ±100 g. Operable temperature range is −70°F to +300°F. Combined effects of linearity and hysteresis do not exceed ±0.75% of full range output for each axis.

The mounting structure of the 4-204 is fitted with three factory-interchangeable accelerometer modules. Each module consists of a four-active-arm, spring-type unbonded strain gage element and a seismic mass damped by the shear action of a viscous fluid.

Circle No. 243 on Subscriber Service Card

## VHF FM Transmitter

A solid-state 3-watt VHF FM transmitter meeting operational specifications for aerospace applications is available from Electronic Communications, Inc. ECI Model 503A, covering the 215-260-mc range, can be operated continuously at an ambient temperature of 85°C. It is electrically and mechanically designed to operate under any pressure from three atmospheres to vacuum.

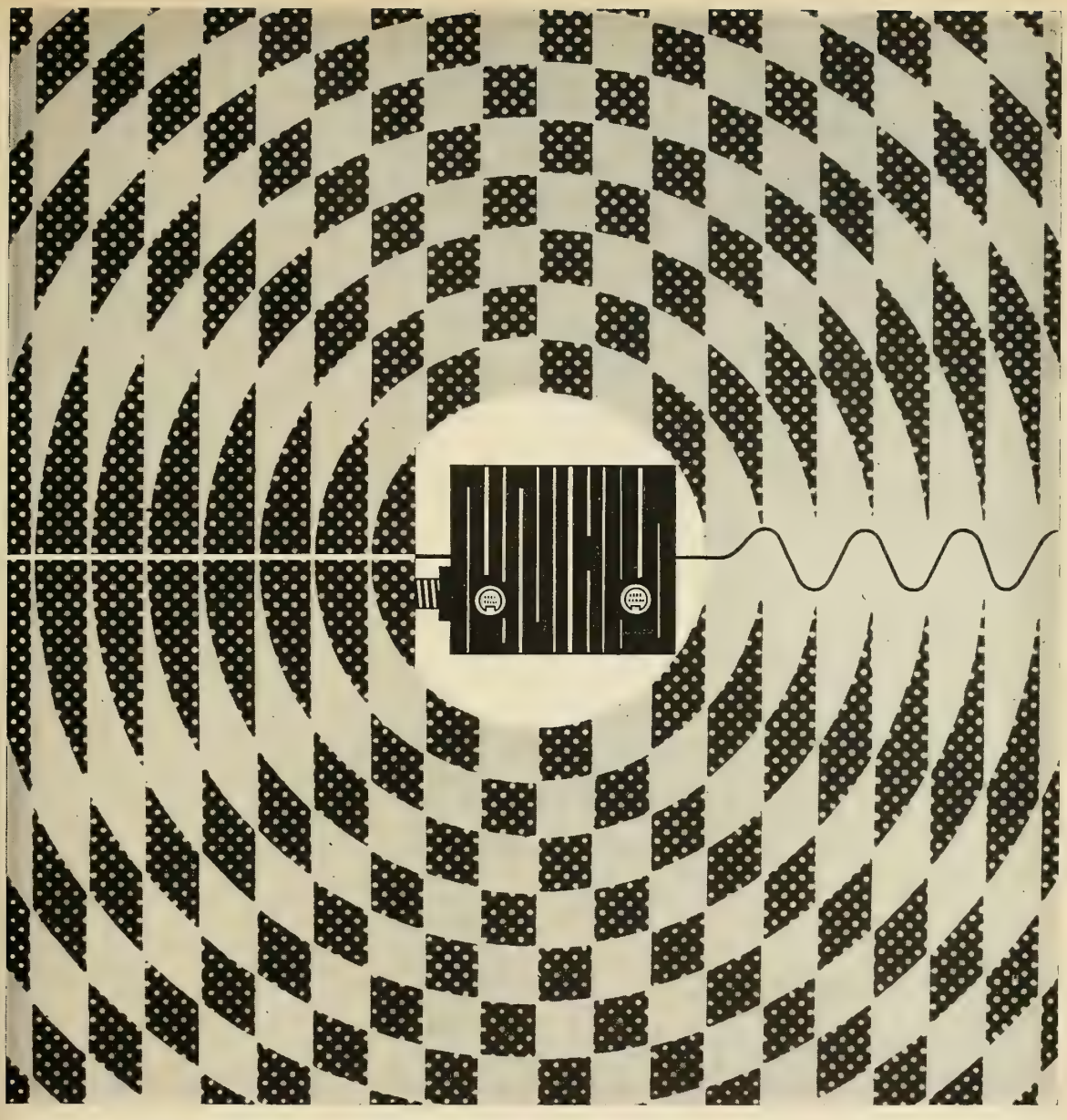
The transmitter can withstand 100-g acceleration and 100-g impact, as well as the vibration experienced in a space vehicle.

Cirle No. 244 on Subscriber Service Card

## Monitor Receiver

Spartron Electronics, division of Sparton Corp., has developed an electronic equipment monitor receiver, ID993/ASQ-67 in accordance with Alri document No. ALR-547. The receiver has 26 preset channels, tunes 1,750 channels and has FM-FSK reception. It has an electroluminescent lighting panel and is completely crystal controlled. Direct frequency readout is provided.

Circle No. 245 on Subscriber Service Card



# HOW 6 TRANSISTORS CAN WORK 7 TIMES HARDER WITH ONLY HALF TRYING

*(a report from Delco Radio)*

Sound like a riddle? Well, it was . . . almost. Here's the story.

Delco Radio engineers wanted to build a precision static inverter that was smaller, simpler, lighter, more economical and considerably more powerful than previous models.

Research hit on the idea of current feedback. Following this principle, the engineers designed an amazing inverter using only 6 transistors. Transistor utilization is stepped up 7 times, yet the transistors work at less than 50% of their capacity, run cooler, last longer.

This new Delco 250 VA power supply converts 28 volts DC to 115 volts, 400 cps. Its circuits are a model of simplicity.

The unit is designed for continuous full-load operation at 71 degrees C. still air, yet weighs only 10 lbs., measures 6¼" x 7⅜" x 5". A minimum of components assures extra-high reliability.

The 250 VA Static Inverter is practical hardware today, awaiting your inquiry. Delco Radio may be able to solve your problem in miniaturization, modules, inverters or converters, too. Write to Delco Radio Military Sales Department, Kokomo, Indiana.

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of General Motors • Kokomo, Indiana

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macrosolution to microtesting:

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an alligator clip with a microscopic tip!




A clip for use where no other will do. For testing in the tightest of spots...on printed circuits, transistors, diodes, crowded terminals. Completely insulated right down to the nose.

CLIP: New keyed-in hinge, traditionally snappy Mueller springs. Wire-clinching ears.

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At jobbers' everywhere.

Write factory for free sample packet (Micro-gator, Insulator, Complete new Catalog of all Mueller Clips and Insulators).

Mueller Electric Co.

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CAREER APPOINTMENT

CHIEF ENGINEER

For Staff of 450

An outstanding career position with medium sized plant employing approximately 1,000 persons of which 450 will report to Chief Engineer. Starting salary to $22,000 and potential to advance. Will direct the following engineering activities: aerospace systems, digital communications, advanced equipment, field engineering, technical publications and engineering services. Plant is located in residential suburb of Washington, D. C.

Respondents should have a BS or advanced degree in Electronics and experience at the department or section level, where groups of engineering and support personnel were supervised.

All replies will be treated in absolute confidence and will be answered without delay. Send brief resume to

BOX 84

Missiles & Rockets Magazine
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Washington 5, D. C.

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# contracts and procurements

## AWARDS

### AIR FORCE

$21,800,000—**Massachusetts Institute of Technology,** Cambridge, for defense research and development.

$6,225,000—**International Telephone & Telegraph Co.,** New York City, for installation of communications and command control for *Minuteman* missile sites at Whiteman AFB, Mo.

$5,001,422—**Aerojet-General Corp.,** Azusa, Calif., for research and development work on *Titan II* propulsion systems at Sacramento.

$4,750,000—**Hallicrafter Co.,** Chicago, for airborne and ground electronic equipment (supplemental contract).

$1,800,000—**Radio Corp. of America,** New York City, for final-stage vehicle and services in support of space programs at Burlington, Mass. (supplemental contract).

$1,122,930—**Electronic Communications, Inc.,** St. Petersburg, Fla., for communication equipment and services.

$1,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space programs at Sunnyvale.

$197,000—**Mellon Institute,** Pittsburgh, for a study of electronic collision cross-sections.

**Lockheed-California Co.,** Burbank, Calif., for a study of the aerospace future of expandable structures that may orbit Earth or journey to other planets (undisclosed amount).

### ARMY

$3,936,660—**Atlantic, Gulf and Pacific Co.,** New York City, for dredging and fill work on *Titan III* complexes at Cape Canaveral.

$3,618,500—**Gahagan Dredging Co.,** Tampa, Fla., for dredging work on Complex 39 at Cape Canaveral.

### NAVY

$6,925,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for continued research and development on the *Subroc* missile system.

$5,881,478—**Philco Corp.'s Communications and Electronics Div.,** Philadelphia, for production of guidance and control systems for *Sidewinder 1-A* missiles.

$4,225,600—**Maryland Shipbuilding and Drydocking Co.,** Baltimore, for activation, repair and conversion of the guided missile ship Norton Sound to a *Typhon* weapons system evaluation ship.

$2,200,000—**Aerojet-General Corp.,** Azusa, Calif., for long-lead-time items for the *Mark 46* torpedo test program.

$1,849,353—**Hughes Aircraft Co.,** Los Angeles, for fire-control simulator training equipment for the *Polaris* program.

$1,819,848—**Sanders Associates, Inc.,** Nashua, N.H., for classified electronics equipment.

$1,800,000—**Texas Instruments, Inc.,** Dallas, for continued research and development on the *Shrike* missile system.

$383,000—**Vitro Corp. of America's Vitro Laboratories Div.,** Silver Spring, Md., for hardware items.

### NASA

$494,000—**Hughes Aircraft Co.,** Culver City, Calif., for design and test of an ion engine system exerting a "gentle nudge" of space power to keep "stationary" satellites on precision orbits around the earth.

$227,303—**Noble Co.,** Oakland, Calif., for installation of a pneumatic and electric distribution system on Pad B of Complex 37 which will be used for Block II *Saturn* vehicles.

$71,000—**Image Instruments, Inc.,** Newton, Mass., for development of a scan converter for studying alternate television techniques to be applied in transmitting slow-scan television from spacecraft to standard home television receivers.

**University of Michigan,** Ann Arbor, for radio astronomy experiment instrumentation for *EGO* and *OGO* series scientific satellites (undisclosed amount).

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

Ogden Air Materiel Area

Attn: Directorate of Procurement and Production

Hill Air Force Base, Utah

FSN 13758945689MA29 cartridge assembly launch gear for *GAM-72* launch system—1300 each. Delivery to Hill Air Force Base, Utah. RFP No. 42-600-63-1302-Q. Bid opening 12-5-62. Adequate drawings and specifications are not available and will not be furnished. Requests for proposals have been issued to the McDonnell Aircraft Co., St. Louis, Mo. and the American Machine and Foundry Manufacturing Co., Niles, Ill. For further information contact J. F. Meadows/OOPAM, Hill Air Force Base, Utah.

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Department of the Navy

Bureau of Naval Weapons

Washington 25, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Vitro Laboratories, Division of Vitro Corp., Silver Spring, Md., for services and materials necessary to conduct a training program on the *Terrier* guided missile weapon system. Award will be made on the basis of a continuation of a program previously undertaken by the above firm. This notice is made for information purposes only. C/N 2321-63. BuWeps Synopsis No. 149-63.

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Ogden Air Materiel Area

Attn: Directorate of Procurement and Production

Hill Air Force Base, Utah

Propellant charges, FSN 1336-709-8320. Applicable to Gar 3/3A/4A—2492 each. Delivery to Olmstead Air Force Base, Pa. RFP No. 42-600-63-1301-Q. Approximate RFP due date 12-1-62. Adequate drawings and specifications are not available and will not be furnished. Requests for proposals have been issued to the following firms: Hughes Aircraft Co., Culver City, Calif. and Amoco Chemical Corp., Seymour, Ind. For further information contact J. F. Meadows/OOPAM, Hill Air Force Base, Utah.

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Direct Support (Guided) Division

Directorate of Procurement and Production

U.S. Army Missile Command

Redstone Arsenal, Ala.

Power supplies, Lambda Model 71, for use as a comopnent of the ENTAC missile test equipment. Delivery destination is: Letterkenny Army Depot, Chambersburg, Pa., 50 each. Lambda Electronics Corp. developed this item and has applied for a patent. Documentation is not available; therefore, it was determined that competitive procurement was not feasible. All inquiries relative to subcontracting opportunities should be referred to the Lambda Electronic Corp., 515 Broad Hollow Rd., Huntington, L.I., N.Y.

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Bureau of Naval Weapons

Washington 25, D.C.

The Bureau of Naval Weapons contemplates entering negotiations with the following firms for a quantity of fuzes, guided missile MK 34 MOD 2: (1) Eastman Kodak Co., A&O Div., 400 Plymouth Ave., North, Rochester, N.Y., (2) Elgin National Watch Co., Communications Div., 366 Bluff City Blvd., Elgin, Ill., (3) General Time Corp., Westclox Div., LaSalle, Ill., (4) Hamilton Watch Co., West End and Columbus Aves., Lancaster, Pa., (5) Bulova Watch Co., Bulova Park, Jackson Heights, N.Y., (6) E. Ingraham Co., 392 N. Main St., Bristol, Conn. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting opportunities should contact the above firms direct referencing C/N 0227-63. BuWeps Synopsis No. 147-63.

If you are in the inertial field **now**, you are undoubtedly the kind of technical man who prefers to work in demanding frontier areas... for it is only 7 years since inertial guidance for ICBM's was only a dream on the drawing boards of a handful of companies. ☐ If you participated — as engineers and scientists at General Precision Aerospace did — in bringing missile inertial systems into the realm of practicality — you will be ready and eager to move into **the new pioneer guidance area — hybrid stellar-inertial systems.** ☐ We suggest you take a close look at opportunities available now with General Precision Aerospace. ☐ **This is one of few firms in the country with a full, in-house capability to design, develop and provide systems management for stellar-inertial systems.** Here the STINGS stellar-inertial program for the Air Force is just phasing out. Among its recent awards is the responsibility for providing a stellar-inertial guidance and control system for MMRBM —Mobile Mid-Range Ballistic Missile. ☐ Positions are available with the Systems Division on MMRBM and on a diversity of other advanced electronic systems programs as well, including:

- **development of electronic instrumentation and ground checkout equipment for guidance test complex at a major Air Force Development Center**
- **marine and avionic guidance systems**
- **space vehicle telemetry**

ENGINEERS SCIENTISTS

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## inquire about immediate assignments at senior and intermediate levels

**Senior Staff Analysts — System Synthesis**
Analytical engineers with thorough knowledge of feedback control and inertial guidance systems will find conceptual problems in Mass Simulations, Guidance Equation Mechanization, Numerical Analysis, Airborne Digital Computer Analysis, Stellar Navigation, Flight Control, Digital Systems, Targeting, Re-entry Prediction and Trajectory Optimization. Initial contributions can be on terrestrial or ballistic guidance systems involving stellar-inertial techniques.

**Staff Engineers — Inertial Guidance Systems Engineering**
Systems engineers with comprehensive knowledge of inertial guidance systems will specify and integrate stable platform, gyro, celestial tracker and airborne digital computer subsystems into state-of-the-art stellar-inertial guidance systems.

**Staff Engineers — Digital Controls & Displays**
Senior and intermediate instrumentation engineers with space or aircraft control panel display experience in CRT's, simulators, trainers, indicators to specify systems design for digital computer and display compatibility. MS or BSEE with experience in self-checking systems.

**Staff Engineers — Vehicle Engineering**
Senior analytical engineers with vehicle subsystems experience capable of individual contributions during early department staffing in these fields: **Aerothermodynamic Analysis** — Shock waves and Thermal density variation. **Power Plant Analysis** — Solar, Battery, Thermo, Nuclear or Electro-static. **Natural or Induced Environmental Analysis** — Airborne Compartments—Noise, Shock, Vacuum, Acoustics and Thermal Controls.
All positions offer potential management levels in a department concerned with predicting vehicle effects on guidance and control systems.

**Project Engineers — Operational Ground Equipment**
Inertial guidance engineers with operational missile systems experience (Polaris, Atlas, Minuteman, etc.) can move on to a new and more sophisticated system and can contribute to the formulation of a new environmental test facility, analysis of system test requirements, monitor and integrate sub-contracted GSE design or evaluate established land and sea navigation systems for guidance alignment errors.

**Staff Engineers — Flight Test Analysis & Planning**
Guidance system engineers with both flight test planning, analysis and operational experience implementing missile flight test programs can enter a stellar-inertial guidance program from concept and follow through to flight test on site. Engineering would entail complete flight test plan from design to launch, evaluation of flight test data from FM/FM, PCM/FM telemetry and external tracking radar or the design of airborne missile telemetry and radar tracking systems for external development.

**Project Engineers — Digital Systems**
Digital systems engineers to specify and apply airborne digital computers to stellar-inertial guidance systems. Experience should include digital system synthesis, inertial guidance systems design or airborne computer programming with extensive work in numerical analysis.

**Scientific Programmers — Analog & Digital**
To solve in conjunction with system engineers complex mathematic analysis problem in servo and error analysis, mass simulations, optimum trajectories, re-entry prediction or airborne computer programming. MS or BS in Math with machine experience on the PACE, RPC 4000 or IBM 7000 series machines desirable.

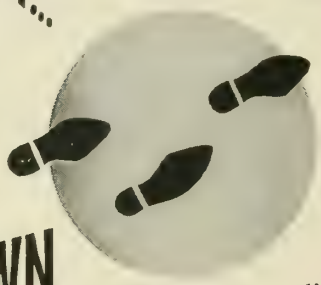
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Grumman will negotiate the contract to design, develop and fabricate the NASA Lunar Excursion Module (LEM) which will be used to achieve the Apollo program's goal of landing astronauts on the moon. Boosted by a three-stage Saturn C-5 vehicle, the Apollo spacecraft will enter lunar orbit and the LEM will separate from the spacecraft to begin its epoch-making descent to the lunar surface. Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit. The Lunar Excursion Module and other space programs at Grumman are creating unprecedented professional opportunities at the company. The momentum generated by these efforts make Grumman an ideal professional environment for scientists and engineers who, like ourselves, are determined to make the unknown known. Those qualified are invited to explore positions immediately available in the following areas.

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Vibration Testing
Space Dynamics
Guidance Dynamics
Control Dynamics
Programming
Aero/Space Frame Systems Integration
Rocket Propulsion Systems
Heat Transfer & Thermodynamics
Gas Dynamics

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Light Weight Space Vehicles
Pressure Vessels
Equipment & Lines Installation
Environmental Control
Rocket Propulsion Systems
Rocket Propulsion System Testing
Airborne Equipment Design

**Electronic Engineering**
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Radar Systems
Communications Systems
Navigation & Guidance
Stabilization & Control
Infrared Systems
Optical Systems Including Lasers
Space Power Supplies
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Logical Design
Digital Systems Programming
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Component Parts Analysis
Reliability Test Engineering
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Weight Control
Part Task Trainers

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Digital Techniques
Analog Systems

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Plasma Physics
Applied Mathematics
Materials Research
Nuclear Physics

**Equipment & Process Engineering**
Test Equipment Engineering (Rocket & Electronic)
Welding Engineering
Chemical Process Equipment Engineering

**Manufacturing Engineering**
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Methods Engineering
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Cost Analysis
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Optical Engineering & Metrology
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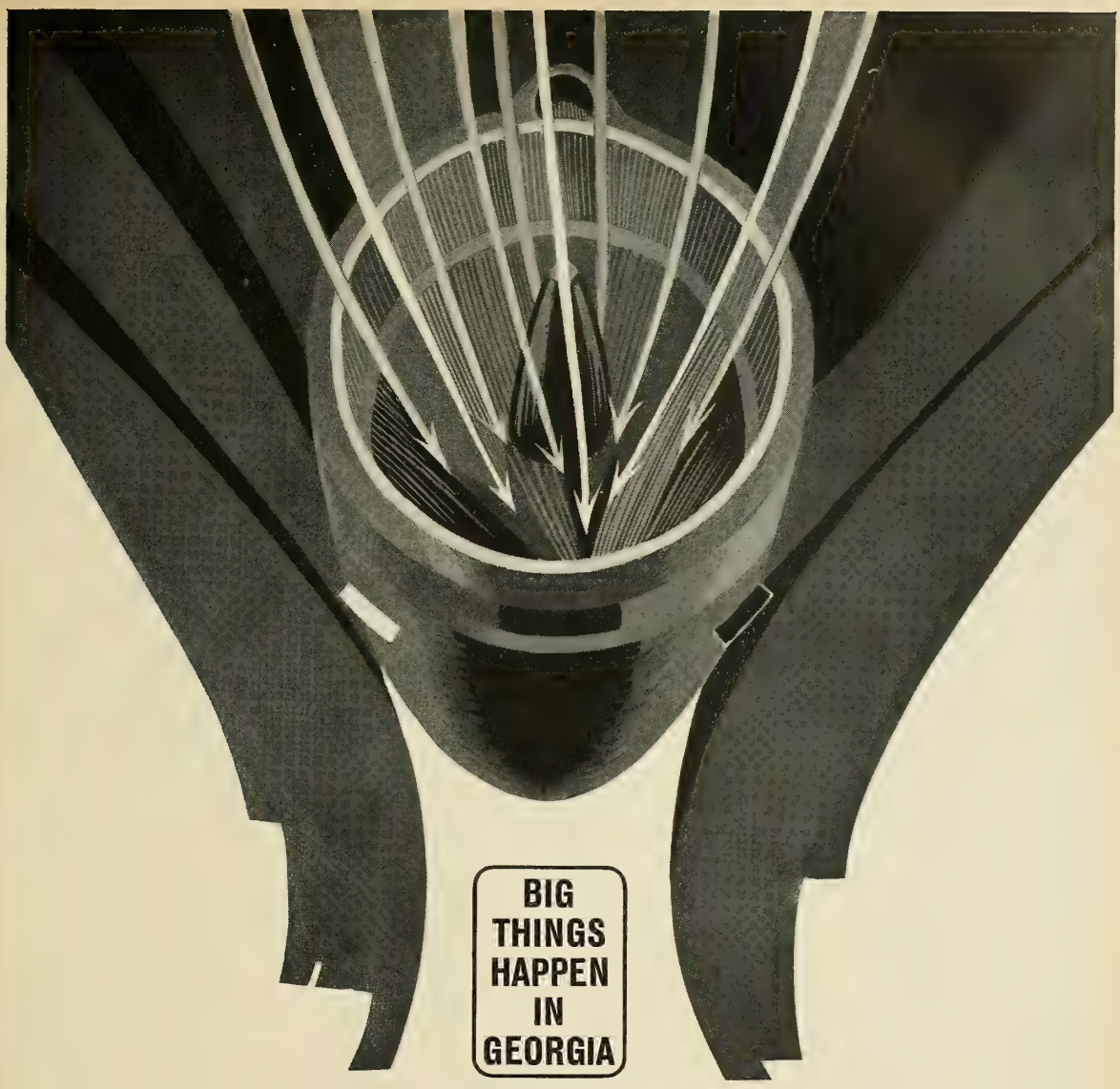
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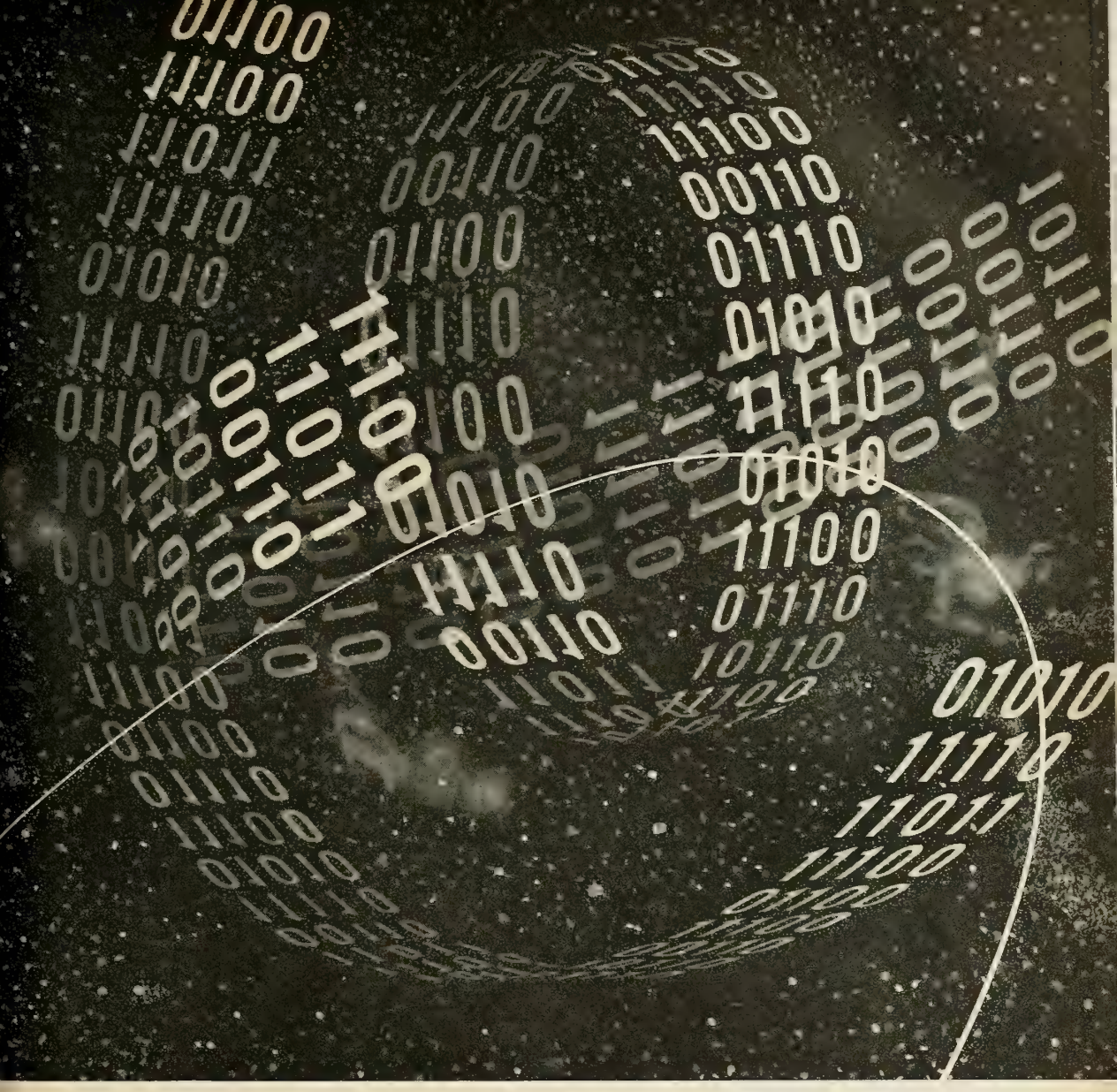



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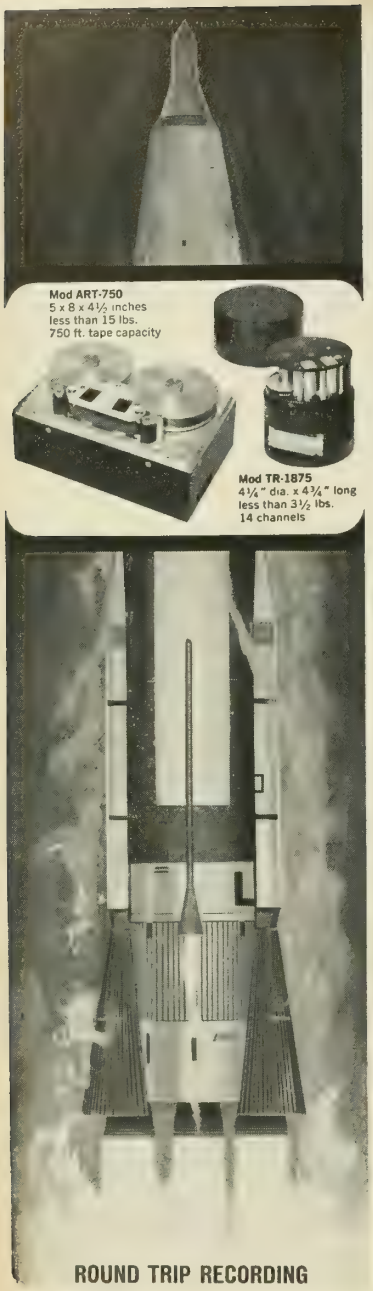
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# names in the news

**Ralph Vecchio:** Chief engineer of Picatinny Arsenal's Propulsion Test Unit, Tech. Services Lab., Dover, N.J., awarded the 1962 Army Research and Development Achievement Award.

**Jess W. Sweetser:** Elected a vice president of the Martin Marietta Corp., Baltimore.

**Dr. Herbert Trotter, Jr.:** Elected chairman of General Telephone & Electronics Laboratories Inc., New York City. **Dr. Lee L. Davenport** succeeds him as president.

**Robert F. Campana:** Appointed manager of procurement for Sylvania Electronic Systems, Buffalo, N.Y.

**Alexander S. Jerrems:** Technical director of Hughes Aircraft Co.'s aerospace group, Culver City, Calif., appointed a consultant to the U.S. Air Force.

**John Vergeichik:** Appointed director of engineering for Fairchild Camera and Instrument Corp.'s Defense Products Div., Clifton, N.J.

**Donald F. Malcolm:** Appointed Washington, D.C., representative for the Boeing Co.

**Jack D. Samuelson:** Named assistant vice president and administrative manager for Emerson Electric's Electronics and Space Div., St. Louis.

**George W. Leisz:** Named vice president and general manager of the inertial navigation product division of Autonetics, a division of North American Aviation, Inc., Downey, Calif.

**Chester C. Pond:** Appointed assistant to the president of General Atronics Corp., Philadelphia.

**John E. Woodward:** Named corporate director of material for Texas Instruments Inc., Dallas.

**Earl C. Vicars:** Appointed technical director of Hexcel Products, Inc., Berkeley, Calif.

**Dr. Milton M. Slawsky:** Director of Engineering Services, Air Force Office of Scientific Research, elected a Fellow Member of the American Rocket Society.

**Zelmer Barson:** Named engineering program manager, missiles and space, for the Cleveland Pneumatic Div. of PneumoDynamics Corp., Cleveland.

**John Mihalic:** Promoted to group vice president of Avco Corp., Cincinnati. **Jack L. Bowers** named vice president and general manager of the Electronics Div., Cincinnati, and **L. R. Zimov** named vice president and general manager of the Ordnance Div., Richmond, Ind. **Wayne D. Hudson** is vice president and general manager of the Aerospace Structures Div., Nashville, Tenn.

**Herbert I. Ackerman:** Named regional sales manager in the mideast for Motorola Semiconductor Products, Inc., Clifton, N.J.

**Billy J. Blackwell:** Appointed applications engineer for Clary Dynamics Corp., Huntsville, Ala.

**William F. Cairns, Jr.:** Appointed executive vice president and vice president-manufacturing of the Maxson Electronics Div. of Maxson Electronics Corp., New York City.

**Dr. Harry J. Watters:** Appointed chief defense engineer, defense engineering group Radio Corp. of America, New York City.

**Albert E. Keleher, Jr.:** Named director of marketing for the Industrial Defense Group of Bulova Watch Co., Inc., Jackson Heights, N.Y.

**Richard A. Davis:** Appointed assistant general manager of the Marquardt Corp.'s Power Systems Div., Van Nuys, Calif.

**C. R. Kazebee:** Named manager of the research and development program for Autonetics' improved *Minuteman* missile, Downey, Calif.

**Allen V. Hazeltine:** Appointed patent counsel and head of the patent department for Philco Corp., Philadelphia.

**Dr. James B. Fisk:** President of Bell Telephone Laboratories, chosen to receive the 1963 Industrial Research Institute Medal.

**Robert W. Stieg:** Named chief engineer at FWD Corp., Clintonville, Wis. **Wesley H. Peters** named general sales manager.

**Harry H. Pfeiffer:** Promoted to manager of operations support for Pan American Airways' Guided Missile Range Div., Cape Canaveral.

**Richard E. Vought:** Named general manager of Microwave Components and Systems Corp., Monrovia, Calif.

**William F. Newbury:** Named production manager for Century Electronics & Instruments, Inc., Tulsa, Okla.

**Dr. Robert M. Whitmer:** Appointed marketing manager for TRW's Space Technology Laboratories, Redondo Beach, Calif.

**Walter A. Holt:** Named vice president of Whirlpool Corp., Benton Harbor, Mich.

**Dr. S. Baron:** Promoted to director of nuclear, process and aerospace engineering, Burns and Roe, Inc., New York City. **T. Y. Mullen** promoted to director of

power engineering, and **M. A. Forrest,** vice president in charge of project operations and a director of the company, made responsible for all production engineering and design.

**Earl Gregory:** Named *Minuteman* program manager for Raytheon Co.'s Semiconductor Div., Mountain View, Calif.

**Richard E. Darnell:** Appointed vice president of the Kenrich Corp., New York City.

**Dr. Leland M. White:** Elected vice president for research and engineering and a member of the operating policy committee of the United States Rubber Co., New York City.

**Bliss M. Bushman:** Elected vice president-engineering at Consolidated Systems Corp., Monrovia, Calif. **Alan B. Dallas** elected vice president-field engineering.

**General Thomas D. White, Dean B. Cowie and Thomas W. Jones:** Elected to the Board of Directors of Aeronca Manufacturing Co., Middletown, Ohio.

**Harris D. Gilbert:** Named director of contracts and planning for Martin Co.'s Nuclear Div., Baltimore.

**Richard A. Hayes:** Appointed marketing manager of the Syosset, N. Y. division of Fairchild Camera and Instrument Corp.'s Defense Products Div.

**Dr. Robert W. Deutsch:** Named physics consultant in the engineering department of Martin Marietta Corp.'s Aerospace Div., Baltimore, Md. **Dr. William J. Levedahl** named engineering manager for compact reactors. **John Psarouthakis** named engineering manager of thermionic power systems and **William A. Vogle** named supervisor of the division's critical facility laboratory.

**Ronald G. Heath:** Appointed sales engineer for Electronic Memories, Inc., Los Angeles.

**Gordon Jones:** Named supervisor of the production estimating section in the Manufacturing Operations Div. of Adler Electronics, Inc., New Rochelle, N. Y.

**Dr. Robert S. Codrington:** Appointed manager, product engineering for Varian Associates' Instrument Div., Palo Alto, Calif.

**Robert O. Gardner:** Appointed director of engineering of Calibration Standards Corp., Alhambra, Calif.

**Vernon L. Smith:** Appointed chief engineer at Radiation Inc., Palo Alto, Calif. **Gene E. Tallmadge** appointed assistant chief engineer.

**Arthur E. Thake:** Named vice president of manufacturing, Consolidated Vacuum Corp., subsidiary of Bell & Howell Co., Rochester, N. Y.

**Douglas A. Buddenhagen:** Named head of the laser products section of the ground systems group of Hughes Aircraft Co., Fullerton, Calif.


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## NOVEMBER

**Western States Section Meeting, The Combustion Institute,** Aerojet-General Corp., Sacramento, Calif., Nov. 26-27.

**American Nuclear Society and Atomic Industrial Forum, Winter Meeting and Atom Fair,** Sheraton-Park and Shoreham Hotels, Washington, Nov. 26-28.

**American Institute of Electrical Engineers, Machine Tools Conference,** Statler Hilton Hotel, Detroit, Nov. 26-28.

**Environmental Testing Seminar, sponsored by Gulton Industries, Inc.,** Metuchen, N.J., Nov. 26-30.

**Radio Technical Commission for Aeronautics, Fall Meeting,** Marriott Motor Hotel, Washington, Nov. 27-29.

**1962 Ultrasonics Symposium, IRE,** Columbia University, New York City, Nov. 28-30.

**Human Factors Society Annual Meeting,** Barbizon Plaza Hotel, New York City, Nov. 28-30.

## DECEMBER

**Fall Joint Computer Conference, sponsored by American Federation of Information Processing Societies and IRE,** Sheraton Hotel, Philadelphia, Dec. 4-6.

**First Annual Symposium on Unconventional Inertial Sensors,** Republic Aviation Corp.'s Paul Moore Research & Development Center, Farmingdale, N.Y., Dec. 10-11 (classified).


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# The NASA Budget

CONGRESS WILL FACE one of its most important responsibilities in reviewing the Fiscal 1964 budget of the National Aeronautics and Space Administration. Not the least of the questions which must be answered is this one: "Is the Administration devoting every resource to achieving manned lunar landing before the Russians do?"

There are high officials in NASA who do not believe that it is.

There is no question that a great amount of money is being spent on our manned spaceflight programs.

But we cannot, as a nation, be frightened at the sheer size of the NASA budget. We must ask, is it enough to do the job? And it must be kept clearly in mind what that job is.

The national goal is not the landing of a team of U. S. astronauts on the Moon in this decade. The goal is landing them there *before the Russians accomplish the same feat.*

Until it is publicly acknowledged that our national objective has been changed, we must provide all the financial support required to do the job.

The President has not declared: "We will make every effort to beat the Russians to the Moon within a $5.5-billion budget."

He has not declared: "We will make every effort to achieve the first lunar landing while we also carry out an extensive scientific satellite program which has equal priority."

The President has made it quite clear what the objective is. The Administration now must back fully the drive to reach that goal. The NASA and industry team working on the *Apollo* project must have assurance that every need will be met, that solutions will be sought for every unknown which might hamper the mission, that they can call without hindrance on any national resource—be it money, manpower or facilities.

It is incumbent on all Congressional committees reviewing the budget for the manned lunar program to ask industry and NASA officials directing the program whether they have everything required to do the job. If the answer is negative, Congress must find out why.

It is equally incumbent on the program officials concerned to answer all such questions frankly, whether or not they risk official wrath. If they do not reply openly, both the program and national prestige will be jeopardized.

It is encouraging to note that some members of Congressional subcommittees concerned with the space program already are engaged in field trips to study NASA requirements for the coming year. This type of homework will pay off when the budget goes to the Hill.

We do not intend to imply that financial irresponsibility should be tolerated in the lunar program. We think the recent cost-reduction drive in the *Apollo* project was a healthy one. Both industry and NASA sources tell us it was conducted on a sound, business-like basis. Trimming of frills from the program can force it more directly onto course.

BUT WE ARE somewhat more concerned with the NASA reprograming which has been forced by the prospective FY '64 budget ceiling. Our concern here differs somewhat, however, with the feelings of many in the space agency.

We, too, feel that scientific satellites, interplanetary programs, and space stations deserve adequate financial support. But if it is necessary to cut these back to provide full support for *Apollo,* there can be no other choice. NASA and industry personnel connected with the programs, disappointed though they may be, also must keep in mind the national objective—the U. S. intention to be first on the Moon. If a NASA program does not contribute directly to that objective, it has to be considered expendable.

Care must be taken, however, not to endanger NASA projects which will provide valuable scientific and technical information for Project *Apollo.* There are many unknowns still to be solved.

We do not favor, therefore, the budget cuts in the *Gemini* program. Many NASA officials share this concern. Financial considerations may make it necessary to look on *Gemini* for the present as an "interim" program rather than an end in itself. But it must not be forgotten that valuable data for Project *Apollo* will be gained from Project *Gemini.*

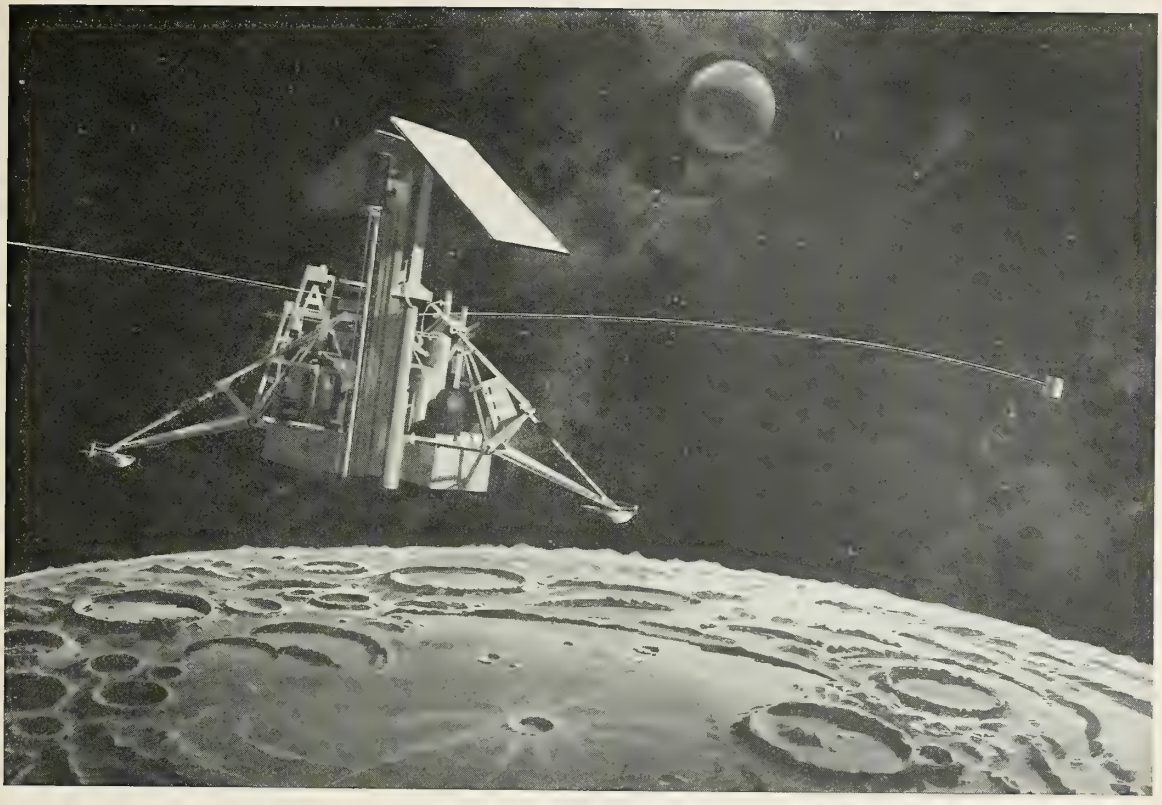
Rendezvous and docking, for example, will be vital to *Apollo.* Hazards of radiation and meteorites will be critical. The ability to maneuver spacecraft will be essential. *Gemini* will contribute greatly to our knowledge in all of these areas and design considerations for the *Apollo* modules will depend to some extent on the *Gemini* input.

The prospect of a four-to-six-month lag in the *Gemini* program definitely is disheartening. Although not apparent now, this lag could be reflected later in the lunar program. We are dealing in unknowns and a six-month delay in obtaining a piece of information vital to *Apollo* design could wreck our chances of defeating the Russians in the lunar race. *Gemini* should be restored to an 18-month program.

We appreciate that it is a delicate financial course which must be steered. But a heavy hand on either the till or the tiller could wreck the ship.

**William J. Coughlin**

## Problem for you:



# Soft land this vehicle on the moon

This spacecraft is SURVEYOR, one of the many important projects now under way at Hughes. It will "soft" land on the moon sometime in 1963. Its mission: to pierce and analyze the moon's surface; to transmit back to earth high quality television pictures; and to measure the moon's magnetic and radiation characteristics. To accomplish these demanding objectives, Project Surveyor requires the talents of many imaginative junior and senior engineers and physicists to augment its outstanding staff. A degree from an accredited university and U.S. citizenship are required. Experience in Aerospace Vehicles is preferred but not necessary. A few of the openings include:

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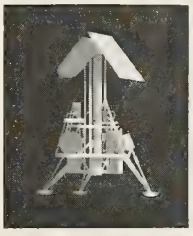
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**Head of Employment,**
**Hughes Aerospace Divisions,**
**11940 W. Jefferson Blvd.,**
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We promise a reply within one week.

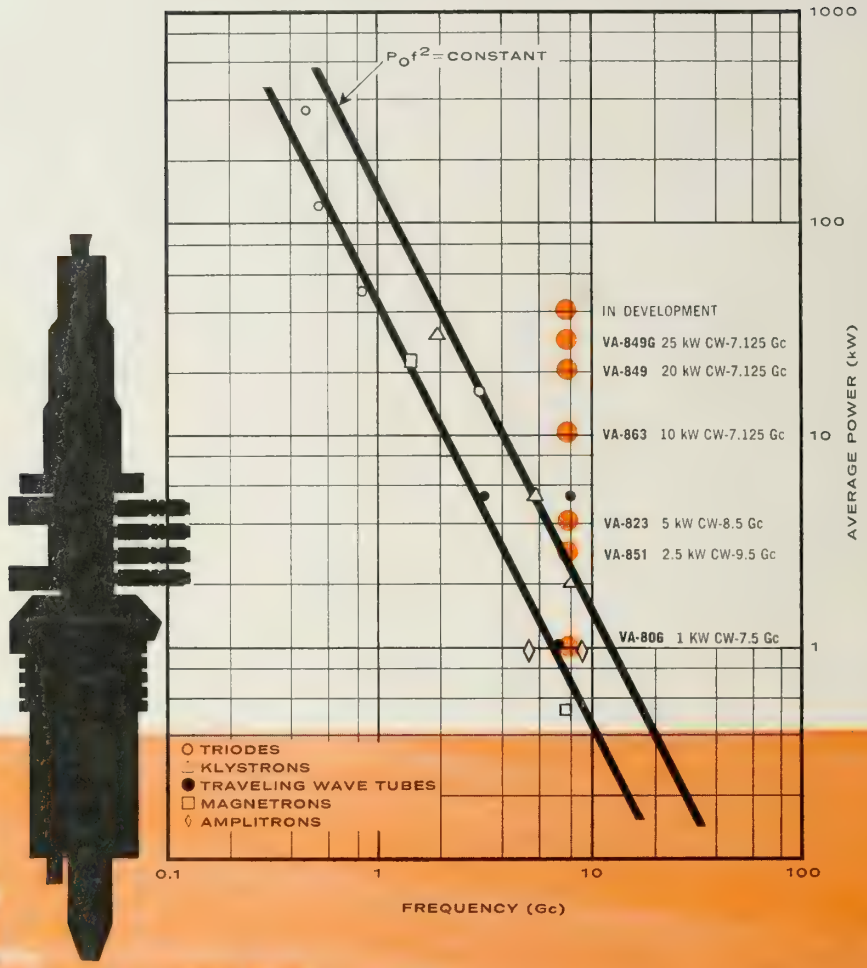


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Power surveys by Nergaard,* plotting power output as a function of frequency for tubes of varying powers, predicted that maximum average available in X-band would be less than 10 kW CW.

Varian research indicates this figure to be extremely conservative. Varian's recent introduction of the VA-849 amplifier klystron provided the industry with a tube capable of developing 20 kW CW power at 7.125-8.5 Gc. A modified VA-849 developed 51.5 kW power in the laboratory, and is now available as the VA-849G, conservatively rated at 25 kW CW. Varian accomplishments do not stop there. The company is now developing an X-band tube rated at a *minimum* of 50 kW CW.

If *your* microwave project calls for such out-ahead capability in power tube development, write Tube Division. *L. S. Nergaard, RCA Review, Dec., 1960

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# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING



*Inspecting Lockheed Grain*

**Super Hawk May Get Antimissile Role . . .**
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AN AMERICAN AVIATION PUBLICATION




Recent aerodynamic and structural tests by the US Air Force on reinforced fiber glass blades mark another first by Curtiss - Wright — first to have a fiber glass bladed propeller successfully complete the Military Qualification Test.

Designed and built by the Curtiss Division for the Tri-Service X-19 VTOL aircraft, this new lightweight propeller system is no longer a concept, but a proved reality. The inherent advantages are many: fiber glass blades are 40% lighter than conventional blades, less costly to manufacture, and far easier to repair in the field.

The successful military testing of these Curtiss-Wright fiber glass blades—a major milestone in VTOL development—may suggest further evaluation for *your* program. Write for our literature which fully describes the advantages these blades offer to VTOL aircraft.

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# missiles and rockets

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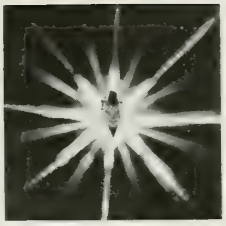
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## THE COVER

*Lockheed Propulsion Co. technician examines newly cast solid-propellant motor at firm's Redlands, Calif., facility. LPC has made motors ranging from 1-lb. Fang to 164,000 lbs. of propellant in 120-in.-diameter applied research motor.*

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# letters

## Merger Balloting

*To the Editor:*

We are somewhat dismayed at certain information presented in your Nov. 19 editorial, "ARS Outdoes Itself." Buried amidst descriptions of some of the displays was the observation that:

". . . Even the returns on the ARS-IAS election carried good news—merger into the American Institute of Aeronautics and Astronautics seemed assured by an overwhelming majority. . . ."

What is disturbing about this item is that we did not receive ballots for this particular election. While this itself may seem unimportant, the disquieting feature is that we were publicly against the ARS-IAS merger.

Indeed, it might be coincidental that two opponents of the proposed merger both failed to obtain ballots, but considering the background, it would appear that perhaps a second balloting should take place —or at least a poll to see what percentage of those opposed (and in favor) of the scheme failed to receive ballots.

Finally, it must be seen whether the "overwhelming majority" of the ARS vote actually comprises the requisite number of members from the total membership to make the merger action valid. To allay suspicion, such totalization ought to be performed by an unbiased outside agency.

We agree with your editorial caption, "ARS Outdoes Itself," it is true. What we wonder is the manner in which the ARS has outdone itself; perhaps what it has done itself out of.

Stephen A. Kallis, Jr.
Associate Member, ARS
B. Spencer Isbell
Senior Member, ARS
Huntsville, Ala.

## AIAA's Challenge

*To the Editor:*

Needless to say, we are all very gratified by the Nov. 19 editorial. It is particularly satisfying in the light of your eloquent criticism of last year's meeting.

As I wrote you some weeks ago, we tried very hard to persuade industrial organizations to make the exhibit a technical one. It is nice to know that you feel that we have fulfilled our objective. You point out that we have "left a magnificent challenge for the AIAA." It is a challenge, indeed. However, we think that the technical displays can be even better than they were this year. At least, it will be our aim to make them better in AIAA.

The 17th Annual Meeting still had its defects. The primary purpose of the meeting was to communicate through the technical sessions. The technical displays were meant to augment those sessions. The session rooms turned out to be too noisy, in spite of the elaborate precautions we took to insulate them from the noise of the displays. In future meetings, we are going to have to solve that problem.

James J. Harford
Executive Secretary
American Rocket Society
New York

## AGARD Corrects Record

*To the Editor:*

The Oct. 1 issue of M/R carries an article entitled "NATO Missiles for Crete," which contains much erroneous information. I shall restrict my comments to the two references to NATO's Advisory Group for Aeronautical Research and Development (AGARD).

Firstly, the visit to the United States by "a high-ranking Greek Defense Ministry team" was *not* sponsored by AGARD, but rather was arranged as a result of initiative taken by AGARD.

Secondly, AGARD has *not* selected a target for the NATO Missile Firing Installation (NAMFI), nor has it ever intimated that it was empowered to do so.

F. L. Wattendorf
Director
AGARD
Paris

## Comprehensive Reporting

*To the Editor:*

Willard E. Wilks' story on Aeronutronic ("Aeronutronic Expanding Production," M/R, Nov. 12, p. 37) is one of the most comprehensive reports on our organization that has been published.

We are naturally pleased at the prominent attention given by your magazine to this management story.

The article will serve as a valuable report to our Government and military customers and the other members of the aerospace industry in defining the current and future role of Ford Motor Company in the aerospace and related fields.

John B. Lawson
General Manager
Aeronutronic Division
Ford Motor Co.
Newport Beach, Calif.

## The Ethics of Fame

*To the Editor:*

Among the vituperative criticisms, in your Nov. 26 issue, of your Nov. 5 editorial I find no appreciative word for those many scientists and engineers whose inventive zeal and design skills made these manned (and all other) space flights possible.

What financial rewards (and worldwide fame) have these *creators* of space apparatus received, beyond a mere living salary?

Just as the engineer of a locomotive


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or the captain of a ship is raised to the top of the totem pole in public esteem and rewards, so are those who ride the space vehicles. Had they themselves first conceived and engineered them and then rode them to glory and riches, then—but only then—should they have the highest respect and admiration of the world.

As matters stand, they did but little more than the monkeys who also went along on such space rides, although it took much training and plenty of guts to do it. My hat is off to them, but I won't crawl on my belly, bearing gifts, in adulation of them.

B. F. Miesner
Miami Shores, Fla.

## Biggest Telescopes

*To the Editor:*

In an item, "Lunar Photos Released" (M/R, Nov. 19, p. 13), you referred to lunar photos being taken by a 200-in. reflecting telescope at Lick Observatory, near San Jose, Calif. If I may, I should like to point out that the 200-in. telescope is *not* at the Lick Observatory, but at the Mt. Palomar Observatory in southern California. The largest telescope at Lick is the 120-in., which was completed in 1958.

Please let me and your readers know which took the photos: the 200-in. telescope at Mt. Palomar or the 120-in. at Lick.

Eldon Byland
Charlotte, N.C.

*The photos were taken by the Lick Observatory telescope. The 200-in. reference is a typographical error. The 120-in. Lick telescope is the second largest reflecting telescope in the world—second only to the 200-in. telescope at Mt. Palomar.—Ed.*


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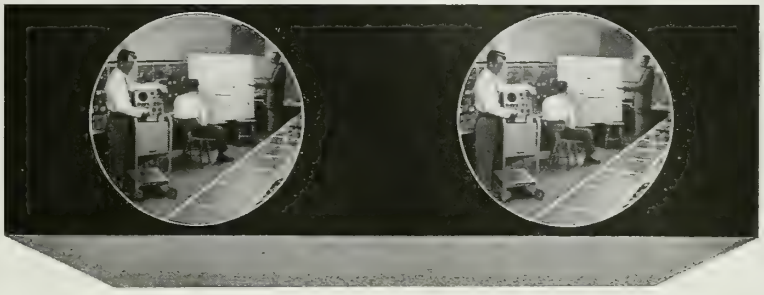
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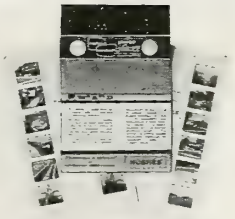
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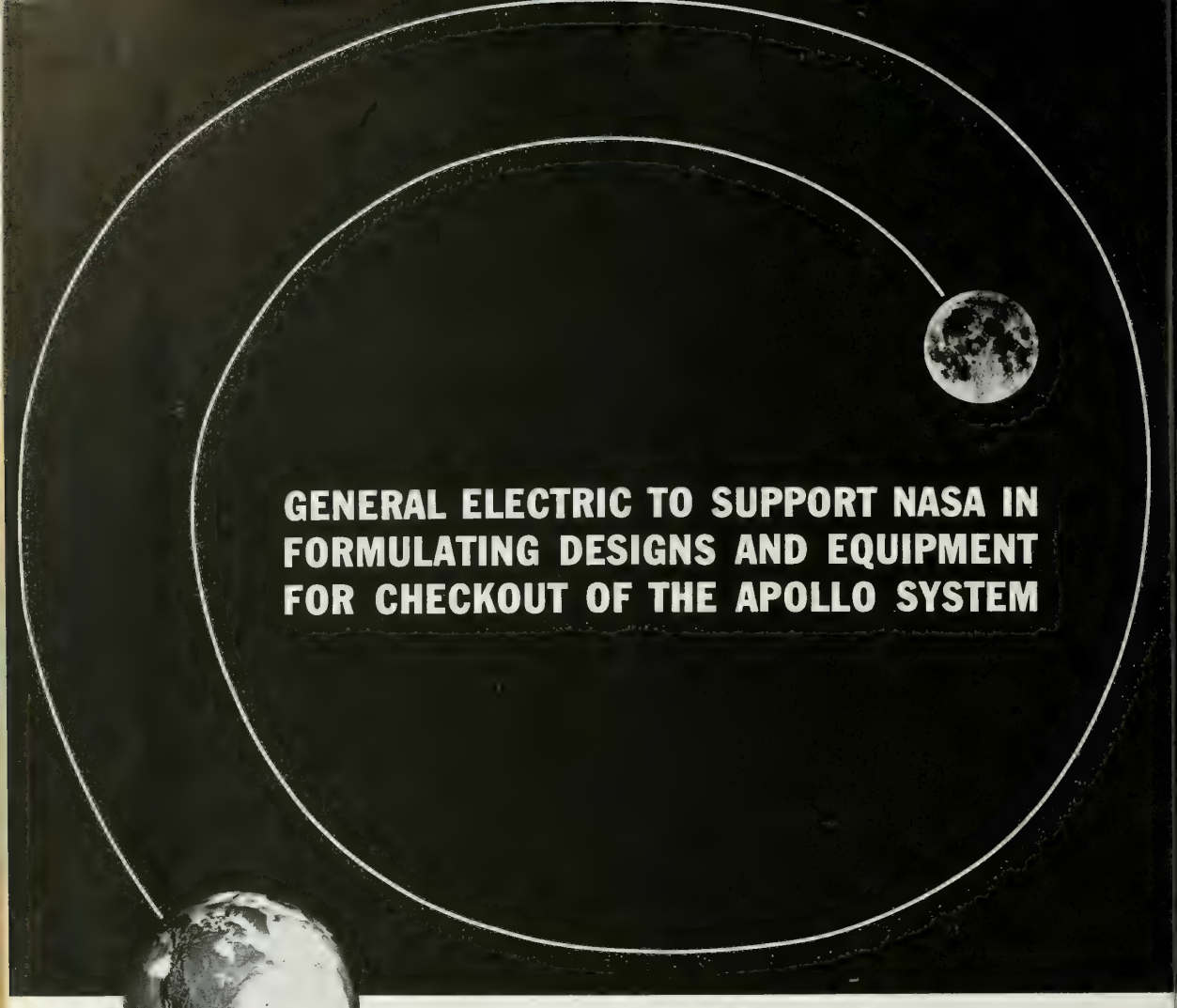


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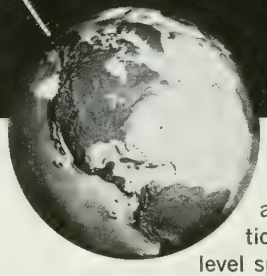
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# The Countdown

## WASHINGTON

### Navy Studies Missiles for Space

A feasibility program to determine whether *Terrier, Talos* and *Tartar* missiles can be used to launch weather and reconnaissance space probes is under way at the Navy Missile Development Center, Pt. Mugu, Calif. Main advantage of such a system: any ship carrying these surface-to-air missiles as armament could use them to gather weather or intelligence data.

### Dyna-Soar Funding Soars

Dept. of Defense will use the entire FY '63 appropriation of $115 million requested for *Dyna-Soar* as well as the congressional add-on of $42 million. This is a decided shift in program emphasis. In FY '62, DOD allowed Air Force to spend only $100 million of the $185.5 million which was appropriate for *Dyna-Soar*.

### Two Major Launches Still Left

NASA has two major launches left on its schedule before the end of the year. First will be the *Thor*-boosted *Relay* active communications satellite, set for Dec. 11 at Cape Canaveral. It will be followed on Dec. 15 by the *S-55B* micrometeoroid satellite, using a *Scout* booster from Wallops Island.

### Centaur Reorganization Still Incomplete

Reorganization of the *Centaur* program by NASA will not be completed until the first of next year. Officials now believe the second launch of the liquid-hydrogen upper stage will slip well past the scheduled target of the first quarter of 1963.

### Bids to be Asked on Space Lab

Langley Research Center will ask for bids within the next few weeks on design of a multimillion-dollar Space Radiation Effects Laboratory. Total cost of the project is estimated at $21.2 million.

### Lunar Contractor to be Announced

This week, NASA is expected to announce selection of a contractor to make a study of lunar base construction. This is regarded by the agency as the first step in a program leading to establishment of a Moon base late in this decade or early in the 1970's.

### What to Do with Turkey Left-Overs?

Reports from Europe are persisting that the U.S. plans to take its obsolescing *Jupiter* missiles out of Turkey. Defense Dept. officials say it's not so. But there's a good reason for the pull-out which is unconnected with any U.S.-USSR deal over Cuba: the IRBM's no longer are needed there.

### Skybolt In Danger of Cancellation

Pentagon insiders warn that heavy cost overruns and technical difficulties could result in cancellation of the *Skybolt* ALBM. DOD officially has denied the report—but only half-heartedly.

### Missile B Is Now Lance

*Missile B* now has officially been re-named *Lance*, the Army announced last week. This puts an end to widespread rumors that it would be called the *Marshall* and confirms COUNTDOWN's report of last summer (M/R, July 16, p. 9).

### Agena-Gemini Decision May Be Delayed

NASA's abrupt decision to consider elimination of the *Agena* target vehicle from the *Gemini* program (M/R, Nov. 26, p. 62) caught many Administration space experts by surprise. This could delay any announcement—although NASA says it will make the final decision in a week or so.

### AEC to Study NASA Nuclear Unit

NASA has asked the Atomic Energy Commission to study feasibility of a nuclear power unit with a 40-watt capability for its Interplanetary Monitoring Probes. The space agency expects to start launching these in 1964. About two units per year will be needed over a four-year period. But the agency has made it plain in a letter to Rep. Melvin D. Price (D-Ill.) that no other extensive use of nuclear power units will be made until at least 1967-68.

## INDUSTRY

### Shillelagh to Get Go-Ahead

Pentagon officials won't confirm it yet but *Shillelagh* definitely has gotten the nod over *TOW* in the antitank missile competition. First cold-weather testing of the Aeronutronic missile will get under way soon near Ft. Greeley, Fairbanks, Alaska.

### Super-Propellants Are in Prospect

Successful synthesis of hitherto unproducible propellants by Rocket Power, Inc., Mesa, Ariz., has raised Air Force hopes for super-propellants which will exceed the specific impulse of existing chemical types. The process, developed under a $200,000 contract from the AF Office of Scientific Research, involves ionizing one chemical component of a proposed compound and directing the ion beam against another component. Ion energy is on the order of only 1 ev. Although nitrobenzine is the only unclassified propellant produced to date by the technique, synthesis of fluorine compounds also is being investigated.

## INTERNATIONAL

### Blue Streak Launch Near at Woomera

First launching of Britain's *Blue Streak* rocket at the Woomera, Australia, missile range is due this month. One of the final static tests at Spadeadam, Cumberland, was held Nov. 23.

### New British Weapon Under Development

In collaboration with General Electric and Sperry Gyro, Whitworth-Gloster Aircraft of Britain is building a classified missile for installation on small ships. Designation is *CF-299*.



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Preliminary Design—establishes configuration feasibility to meet mission changes and future missions as dictated by program requirements.

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# The Missile/Space Week

## Machinists Strike at Lockheed

The union shop controversy that has plagued the missile/space industry in recent months exploded last week into a strike of the International Association of Machinists against Lockheed Aircraft Corp.

The strike began at 12:01 a.m. Nov. 28 and spread from Cape Canaveral to Honolulu by mid-morning.

Almost immediately, President Kennedy set up an inquiry board to look into the dispute and report to him by Dec. 3. This is the traditional first step in procedures under the Taft Hartley Act, possibly leading to a back-to-work court injunction.

The White House said the President has determined that the strike "if permitted to continue, would imperil the national health and safety."

Before the strike began, DOD set up guidelines by which future contracts or contract extensions with Lockheed would need the approval of each of the service secretaries until after the firm's labor difficulties are resolved.

DOD denied charges that the seldom-used procedure was an attempt to force the company to agree to arbitration under threatened loss of upcoming contracts. Spokesmen argued the system was necessary for "protecting the needs and requirements of the defense establishment."

Lockheed Vice President John Canaday told newsmen, "We don't fear an election on the union shop issue. But if we sacrifice a principle, we no longer have a basis on which to stand." He described the firm's position as "a guard against erosion of fundamental rights."

## Mariner Date Still Holds

NASA officials predict that if its present performance continues, the *Mariner II* spacecraft will successfully complete its Venus fly-by mission Dec. 14.

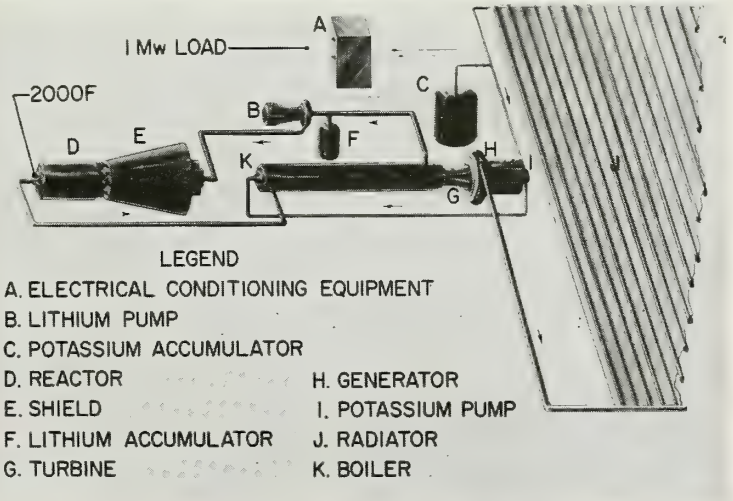
The optimistic outlook was made despite indications the spacecraft temperature is higher than expected and malfunction has reduced the power in one of its solar panels.

NASA also announced that the spacecraft set the world's long-distance space communications record in its 91st day of flight.

At 7:46 a.m., EST, Nov. 25, *Mariner II* reported its condition and data from its scientific experiments to the Johannesburg, South Africa, tracking facility from 22.5 million miles in space.

## First Titan II at Davis AFB

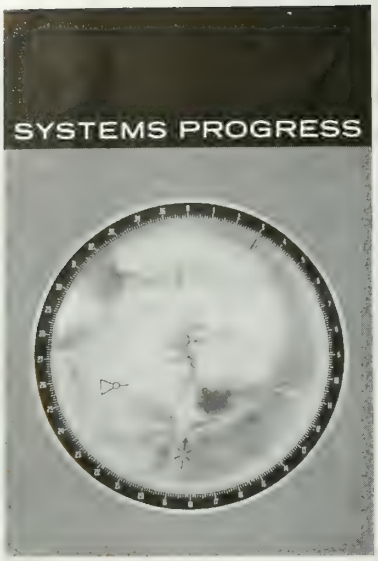
Davis-Monthan AFB near Tucson, Ariz., accepted delivery of its first




### *Pratt & Whitney's SNAP-50 Reactor*

*FIRST RELEASED schematic of Pratt & Whitney's SNAP-50 lithium-cooled reactor system. SNAP-50 is the only high-power nuclear system now being funded, but is not yet in an advanced hardware state. It will yield power in the multi-kilowatt range.*

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Acrylic plastic used for the screen requires special production techniques, with tolerances held to .001 inch. Grid lines are engraved, then hand-filled with titanium oxide.

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*Titan II* ICBM last week. It was flown from Lowry AFB, Colo., in a C-133 and off-loaded at the Missile Assembly Maintenance Shop.

After an extensive checkout and operational preparation, the *Titan II* is scheduled to be installed in Complex 11—the most nearly complete of the 18 launching sites at the base.

## UTC Now Operating Division

Lt. Gen. Donald L. Putt (USAF-ret.), president of United Technology Corp. since it was set up in 1958, has been named a vice president of United Aircraft Corp., the parent firm, in a major reorganization move.

UTC, formerly a subsidiary of United Aircraft, has been made an operating division of UAC, and redesignated the United Technology Center. Putt will be in charge of coordinating all West Coast activities of UAC's operating divisions and subsidiaries.

Barnet R. Adelman, executive vice president of UTC, succeeds Putt as head of the new division.



PUTT



ADELMAN

At the same time, UAC named the general managers of all its other divisions to be division presidents. These include Leonard C. Mallet of Pratt & Whitney Aircraft; William E. Diefenderfer, Hamilton Standard; Lee S. Johnson, Sikorsky Aircraft; John N. Phillips, Norden; and Charles M. Kearns, Jr., United Aircraft Corporate Systems Center. Mallet, Johnson and Kearns also will continue as UAC vice presidents.

## Shots of the Week

The Air Force launched two secret payloads from the Pacific Missile Range last week.

On Nov. 21, a space probe was boosted by a *Blue Scout* vehicle.

This was followed on Nov. 24 with the launching of a secret satellite using a *Thor-Agena* booster combination.

AF announcements gave no details on either shot. In the past, however, the *Blue Scout* has been used for radiation probes. The *Thor-Agena* also has been used as the booster for the *Discoverer* satellite series.

• The Army's *Pershing* missile chalked up another successful mission. The missile, made by Martin Marietta Corp., weighed only slightly more during the Nov. 27 shot than the planned operational version.

Fired from its operational field equipment, the *Pershing* made a 300-mile flight for its 36th success in 43 launches.

• A *Skybolt* was launched from a B-52 at 1:45 p.m. Nov. 28 over Cape Canaveral. After separation from the plane and ignition of the first stage, the missile failed to gain altitude and dropped into the ocean.

## Urey vs. Schriever: Round 2

A running debate about the military merits of the Moon moved to the East Coast last week when Dr. Harold C. Urey, Nobel prize winner and professor of chemistry at the University of California, stated in Washington, D.C., that the Moon and national defense have nothing in common.

At the American Rocket Society meeting in Los Angeles last month, Urey had argued the same point with Gen. Bernard A. Schriever, commander of the Air Force Systems Command. At that time, the Nobel scientist said he would not "spend one effort of my little finger" for weapons in space (M/R, Nov. 26, p. 17).

Pressing further, Urey said the Soviet people have a direct quality about them: if nuclear war comes, they will have set up their missiles and will fire them between Earth points—they will not bother putting bombs either on the Moon or in orbit.

## TFX Aircraft Approved

Development of the air-to-air missile and fire-control system for the TFX aircraft is expected to cost approximately $200 million, DOD officials said last week in awarding the long-awaited TFX development contract. Winner of the aircraft development and procurement award over the Boeing Co. was General Dynamics/Grumman team.

Hughes Aircraft Co. had earlier been selected by the Navy to develop the missile and fire-control systems. The Navy's Bureau of Weapons has also awarded a contract to the Cornell Aeronautical Laboratory for study, evaluation and analysis of a long-range air-to-air missile for the tri-service fighter.


Circle No. 3 on Subscriber Service Card

## NRDS Proposals Sought

NASA and the Atomic Energy Commission have asked industry for proposals for a contract to provide support services at the Nuclear Rocket Development Station in Nevada, emphasizing that the contractor must have "significant" technical capabilities in addition to plant engineering and housekeeping competence.

The areas requiring technical competence were identified as cryogenic technology, involving the use of liquified gases at extremely low temperatures; radiation monitoring; temporary storage of radioactive wastes; computer operation; and the operation of shops and special equipment such as mobile shielded vehicles.

The contract will call for NRDS base-support services and limited support to the Los Alamos Scientific Laboratory, Aerojet-General, Westinghouse Electric, Lockheed and other contractors involved in nuclear rocket research at the Nevada site. Inquiries should be directed to the chief of the Space Nuclear Propulsion Office, Nevada Extension, P.O. Box 1676, Las Vegas, Nev.

## Titan III Test Stand Begun

Air Force Space Systems Div. broke ground at Edwards AFB Nov. 29 for construction of the world's biggest and most highly instrumented solid-rocket engine test facility.

The stand is primarily to test the five-segment 120-in. solid rockets for *Titan III,* but it has the capacity to test segmented solid rockets up to and including 156-in.

Construction and instrumentation will cost $8 million. The new test stand is adjacent to the old *Minuteman* test site at Edwards.

## Lunar Fashions by Latex

A quickly donned spacesuit, fabricated by a company usually known for its hard-working women's garments, has won the *Apollo* suit competition.

NASA has selected the Hamilton Standard Div. of United Aircraft Corp. as prime contractor to manage and integrate the spacesuit program. It also will design and produce the life support pack.

Spacesuit fabricator is International Latex Corp., who as principal subcontractor will do engineering and development of the suit. International Latex has already developed a suit under an Air Force contract.


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**Communications.** To conduct analysis and integration of new concepts in telemetry command, detection, and tracking systems.
**Experimental aerodynamics.** To work with a group that will support theoretical aerodynamic research with experimental approaches and will initiate experimental research to fill voids in the theoretical techniques.
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**Guidance and controls.** To conduct study and analysis of sensors and computers.
**Systems research.** To work on systems performance optimization.
**Numerical analysis.** To develop large-scale numerical procedures for aerodynamic design and flow field analysis.
**Avionics.** To work on the design, development, and analysis of avionics systems for airborne applications.
**Reliability.** To assess the reliability and optimize the configuration and mission profiles of space systems.
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If you'd like more information about these opportunities and others that may be available, write to Roy L. Pool, Engineering Center Personnel Office, 1001 East Broadway, Hawthorne, California.

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# Hawk May Get Antimissile Role

***Already approved by Army, $40-50-million program might provide anti-tactical missile protection by 1965***

**by James Trainor**

DEPT. OF DEFENSE approval is pending on a $40-50-million development program for a new Raytheon super-*Hawk* ATBM (anti-tactical ballistic missile) weapon system. The program, if approved, will provide a field army ATBM capability as early as 1965.

The design proposal calls for addition of a minimum of equipment to extend capability of the present *Hawk* surface-to-air missile system. New equipment will include a long-range acquisition radar and a high-speed target intercept computer.

The Army Secretary already has approved the program as part of the FY '64 budget. Major advantage of the Raytheon proposal is its ability to provide a quick method of achieving a battlefield antimissile capability at minimum cost.

Final decision on a go-ahead for the super-*Hawk* must also cover *Mauler* and *Field Army Ballistic Missile Defense System* (*FABMDS*) as possible alternatives.

Pentagon sources report, however, that *FABMDS* now is under serious consideration for development at a later date. It is felt that technological results of the *Nike-Zeus* program should be studied before *FABMDS* development is initiated.

The decision to delay *FABMDS* was evident last week in the final list of project officers for designated systems within the Army's new Materiel Command. Although the list originally included a *FABMDS* office, it no longer exists on the new list.

Army approval of the new *Hawk* program and continued interest in *FABMDS* indicates, however, the possibility of a high-level decision on the question of ICBM defense. One point which held up *FABMDS* and other programs earlier was the need for an overall study of whether this nation could afford ICBM defenses.

If the answer found in this study was favorable, it might also indicate a brighter future for *Nike-Zeus* itself.

Addition of the ATBM capability would be the first real extension of *Hawk* performance. Raytheon Co., prime contractor on the air defense system, is currently producing high-power illumination radars which are just starting to be introduced into deployed battalions. However, this does not represent an improvement in capability, but rather increased performance against the system's design threat.




*RAYTHEON HAWK can now intercept aircraft at ranges up to 38,000 ft.*

• **Hawk's advance** — The proposal to extend the *Hawk* capability to cover the ballistic missile threat was first proposed by the Army approximately two years ago, when the first *Hawk* unit was deployed in Europe. The basic philosophy at the time was to equip only the European units with the missile-killing *Hawk*. Now some Defense officials feel that the system could be effective against submarine-launched ballistic missiles and, therefore, units within the continental United States should be equipped with the system.

After the original proposal, the improved *Hawk* concept was discussed with the NATO users of the system. It was only within the past several months, however, that approval by DOD became a distinct possibility. (Defense officials deny that Cuba had any bearing on revival of the program. The tactical ballistic missile threat already existed and was widely recognized, they point out.)

*Hawk* has already proved its capability against battlefield rockets of the *Honest John* and *Little John* class by successfully intercepting them using only equipment organic to the battalion. However, this presently appears to be a "technical capability" as opposed to an "operational capability" since it depends to a large extent on how long men and equipment can be maintained in a "super-ready" condition under battlefield conditions.

Intercept of a *Corporal* missile has also been accomplished with the *Hawk*. However, this required additional augmentation and modification of tactical equipment. The intercept took place under tightly controlled conditions at the elaborately instrumented White Sands Missile Range, N.M. *Hawk* has not been used to try to intercept second-generation, solid-fueled missiles of the *Sergeant* class. ⌘

# AEC Reorganization Debate Deepens

## *88th Congress will weigh advisability of single administrator instead of present five-man body*

**by Frank G. McGuire**

CONGRESS early next year will take up the question of whether the present five-man Atomic Energy Commission should be replaced by a single administrator. This was disclosed at last week's joint Atomic Industrial Forum and American Nuclear Society meeting in Washington.

The prospect of Congressional hearings on the subject is of considerable significance to the missile/space industry in light of AEC's growing role in the nation's space programs.

The announcement confirmed reports last summer that a single-manager approach to AEC management was under consideration by the Administration (M/R, Aug. 13, p. 54).

The reorganized body probably would be headed by a single manager having control over all programs, but a three-man commission also is a possibility. The latter alternative, replacing the present five-man commission with three men, would be an attempt to retain the advantages of multiple-manager operation, while eliminating some of the more serious charges that there are now too many fingers in the pie.

Sen. John O. Pastore (D-R.I.) and Rep. Chet Holifield (D-Calif.) discussed the possibility at joint press conference shortly after Republican Rep. Craig Hosmer (Calif.) fired the first volley of what is certain to become a major controversy in the management of AEC programs.

Reverberations of hearings now being planned by the Congressional Joint Committee on Atomic Energy on the subject of AEC operations are sure to be felt in nearly every other agency handling advanced research.

Holifield is now chairman of the JCAE; Pastore, now vice chairman, will take over the chairmanship in January as called for by rules giving the two houses of Congress alternating control over the body.

• **Open minds**—Both men said they had no preconceived notions on the subject at this time and will await the outcome of hearings. Pastore said he would favor the single-manager approach if the Administration found such a scheme advisable and took the initiative. Holifield said he wants proof that the present system is not working before he will advocate any changes.

"I have sat through this meeting of nuclear industry representatives and heard them applaud whenever an AEC action was discussed, and yet they all want it abolished!" Holifield commented.

"I want to ask a lot of questions about this before I recommend anything, and I want to look at the alternatives," he said. "The five-man body has many advantages, since the commissioners are Presidential appointees with diverse backgrounds, and I don't know what effects a single-manager system might have on the field. I'd like to explore, for example, the possibility of increased prominence of the AEC's general manager for improved operation of programs. More than anything, however, I want to see proof that the present system hasn't worked."

Both Holifield and Pastore indicated there would be hearings early next year on the subject, with likelihood of considerable controversy over whether or not the present system is, in fact, working as well as necessary to get the job of nuclear development done.

• **Hosmer attacks** — Hosmer, who delivered his remarks to a morning panel discussion in the AIF portion of the joint meeting, has been a frequent critic of nuclear program management. During September hearings covering the *Rover* program, he particularly probed the management of Harold B. Finger's Space Nuclear Propulsion Office, a joint AEC/NASA organization.

(Hammering away at Finger in an effort to determine whether the *Rover* program's manager was overloaded with work, or was delaying important decisions by his extensive absences, Hosmer made it clear he was keeping a sharp lookout for possible loose management practices and other organizational shortcomings. His efforts to uncover poor management in SNPO were unproductive at the time, but he commented, after discussing SNPO's complex, widespread setup with NASA Administrator James Webb: "Mr. Webb, you described this setup as a brilliant organizational jewel and I can't even understand what it is from reading the testimony, let alone hearing it.")

During the AIF panel, Hosmer said JCAE had pre-empted some AEC func-

## *Holifield Hits at 'Moon Madness'*

A BLAST at what he termed "Moon madness" was unleashed during the AIF/ANS meeting by Rep. Chet Holifield (D-Calif.), who deplored the "unbalanced" nature of Federal expenditures on space programs at the expense of other needed programs.

"When this Congress passes, without serious objection, a multibillion-dollar bill to provide NASA with the means for getting us to the Moon, then the Budget Bureau holds up $600,000 of an appropriation for the experimental irradiation of food to test preservation, I think we've got Moon madness," Holifield charged.

Stressing that he is not anti-space, the Chairman of the JCAE said he nevertheless feels much of NASA's budget could be reduced without defeating the U.S. purpose of getting to the Moon. He strongly questioned the priority assigned the manned lunar landing.

"When you give so much of the pie to NASA," he said, "other parts of the pie have got to be smaller." He cited the various atoms-for-peace programs which are now curtailed, but emphasized that he is not advocating the use of funds to detonate nuclear weapons underground ". . . just to show that we can build a harbor. I'm talking about worthwhile, meaningful programs."

tions because of AEC inactivity due to its organizational structure. Singling out research and development functions, Hosmer said the field is one in which success can be neither legislated nor effectively controlled by a commission or a committee.

"The general direction and guidelines for areas of research are functions which at present—to a remarkable extent—have been pre-empted by the JCAE . . . and in nuclear space matters by the President's scientific advisors," the Congressman charged.

Commenting that "The AEC seems pretty much to have become an anachronism at this point in its 16-year history," Hosmer appeared to be anticipating a "whitewash" by adding:

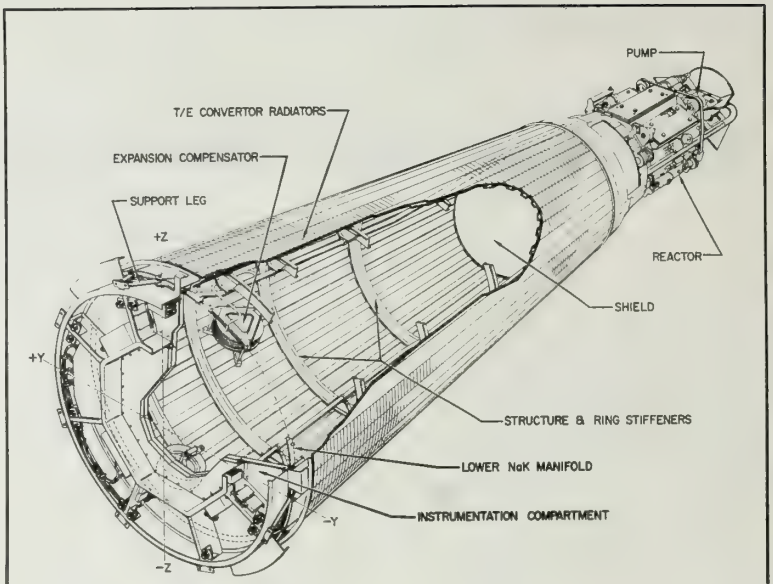
"I predict that the reorganization problem will receive the long and thorough study it deserves, and that the Joint Committee will be slow to disturb the system by which it has come to exercise such dominance over the years that it is reputed to be the most powerful committee of the Congress—and, somehow, the AEC has worked, even though it shouldn't."

Judging by the mood at the joint meeting, Hosmer has considerable support among members of the nuclear fraternity, but how much of the complaining is legitimate criticism of AEC's operation and how much is of a "sour grapes" nature is highly debatable. The civilian electric power industry, one of whose prime battles is government vs. private power, has clashed with AEC.

Laying out what he feels to be the four major problem areas for nuclear energy for the decade ahead, Hosmer cited: (1) continued maintenance of weapons superiority; (2) large-scale development of nuclear space applications; (3) economic civilian nuclear power generation; and (4) transition of peacetime atomic energy from government to private industry.

• **Favors one man**—Hosmer recommended that a "director, not a board of directors" be established to handle the AEC's operations. He pointed at what he called a series of disputes revolving around licensing and regulatory functions, public vs. private power, and disputes between JCAE and AEC on many items of policy. The JCAE is aided in these disputes by the relative permanency of its membership, he said: "Since 1954, defects—alleged or real—have appeared which have led the AEC to recommend its own abolition . . . and many others to second the motion."

Hearings now being planned by JCAE apparently will determine whether an act of Congress amending the Atomic Energy Act will officially second the motion and completely reorganize the government's atomic energy operations. Whether or not any legislation will come out of the hearings has not been predicted, and no estimated date for beginning hearings has been given.




*RECENTLY RELEASED schematic of SNAP 10A.*

• **SNAP level hit**—Criticism of the space nuclear power development pace was voiced by several authors at the meetings. Power supplies for communications satellites were singled out as examples of both too slow a pace and too low a power level.

Jerome G. Morse, director of Martin Marietta Corp.'s auxiliary power systems department, said there are no nuclear space power systems now under specific development for communications satellites, and consequently other systems must be adapted for them.

He recommended that technical requirements for such power supplies be established immediately to "give direction and purpose to present development programs." In laying out the findings of an industry committee to examine nuclear power for space applications, Morse said:

"General acceptance of radioisotope systems and establishment of concrete plans for their use, together with availability of long-lived alpha-emitters at reasonable cost, constitute major problem areas in the development and application of these systems for space power."

Morse pointed out that the largest power system now in hardware development is the *SNAP-8* reactor, with its 30-kw turboelectric conversion unit. Doubling up on the conversion units can make the system put out 60 kw, but this is still in the feasibility study stage.

The only high-power system currently being funded—but not yet in any advanced state of hardware development—is the *SNAP-50* system for power levels in the multi-kilowatt and possibly megawatt range, Morse noted. Other high-power possibilities are offered by thermionic reactor systems, which also may have good characteristics in weight and reliability, and operational usefulness is expected by 1970.

*SNAP-10A*, first reactor system to be flight-tested, is expected to go into orbit in an *Agena* vehicle next year for a period of 500-watt operation. According to Morse, high-temperature materials will allow growth potential in the thermoelectric conversion unit.

Beyond *SNAP-10A* are *SNAP-8*, with first flight due in 1966 for operation of an electric propulsion unit, and *SNAP-2*, the initial flight of which may come shortly before *SNAP-8*. (All are reactor systems, as opposed to the numerous isotope-powered nuclear units being planned. Isotope power units are identified by odd-number designations, and reactor power units are labeled with even numbers.)

Morse recommended greater emphasis on isotope units for communication satellites, and greater coordination in formulation of specific plans for use of thermoelectric and turboelectric power sources. He also urged that earlier attention be given to problems associated with integration of nuclear, non-nuclear and electrical components of a communication satellite payload; and that better data be developed for total system costs in order to accurately

evaluate economies and understand the cross-effects of design on the power system and the launch vehicle.

The final recommendation in the report is a loosening of the clamp on nuclear systems information. "While the need for classification of certain technical information on systems developed by the military is recognized," Morse stated, "many existing restrictions seem to needlessly impede the interchange of information between users and developers, both in industry and government."

In a somewhat parallel series of conclusions, R. P. Haviland of General Electric laid out his company's estimates of future nuclear space power requirements, noting that "one of the major differences between these estimates and the current nuclear space power technology lies in the design lifetime. In general, these estimates indicate that the lifetime must be appreciably greater than is contemplated by existing programs.

"A space power pack of 10,000 hours' operating life is very unattractive in many applications. At 100,000 hours of operating life, the pack probably becomes useful, with a few exceptions for which even longer lives are either highly preferred or necessary."

He points out, in connection with manned operations, that all of the design estimates available are based on "leaky" fast reactors—that is, the neutrons escaping from the reactors become an additional source of particles trapped in radiation belts. This, says Haviland, may be a sufficiently great problem to prevent use of such leaky reactors close to a planet; he suggests that studies be made of the problem.

• **Nuclear propulsion**—Raemer E. Schreiber, Los Alamos Scientific Laboratory's Technical Associate Director, said his organization expects to be out of the *NERVA* business "in a year or so," thus leaving the industrial contractors to pursue *Rover* while LASL turns almost all its nuclear rocketry attention to advanced concepts. He said the key to higher performance lies in these concepts due to temperature limitations of the present solid-core reactor materials.

"Even so," he added, "we need good core-retention schemes to keep a gaseous core inside the reactor." The gaseous core is being looked to, in addition to other concepts, as an answer to the materials temperature-limitation problem. Schreiber noted that even the Kiwi-B series of ground test reactors are still having core structural problems, but that these were relatively under control, and that the reactors have proved to be quite self-stabilizing in operation—even in those instances where portions of the core were ejected from the reactor system.

On a subject not related to the actual design characteristics of the nuclear rockets, Schreiber echoed many other critics—among them are Admiral Hyman G. Rickover and NASA's Werner von Braun—in castigating U.S. industry and its performance.

"During the entire program, we have been greatly disappointed at the consistent failure of contractors simply to meet the agreed specifications of hardware supplied to us," he declared, "and some of our troubles stemmed from unjustified confidence placed on items of hardware."

He cited a hydrogen leakage which caused an explosion at the Nevada test site, delaying the program. "We falsely assumed that closing a high-pressure valve meant we had stopped the hydrogen flow, as per manufacturer's claims," Schreiber noted, adding that the current setup consists of two high-pressure valves on the line in series, with the area between the valves purged by inert gas.

Speaking to a capacity audience during the technical session, he commented briefly on several advanced concepts, becoming more and more reluctant to accept claimed performance figures at face value as the concept became more theoretical. Included were such concepts as fission-fragment recoil, nuclear fusion, photon drive, proton/anti-proton reactions, and others.

Project *Orion* (M/R, Oct. 29 p. 28) came in for somewhat more favorable comment from Schreiber, who has directed the *Rover* effort at LASL since 1955, although he looked askance at the potential specific impulse figure of 100,000 seconds. Aside from plasma or charged-particle accelerators, which derive their electrical energy from nuclear sources, Schreiber pointed out Projects *Rover* and *Orion* as the only two nuclear space propulsion programs now receiving active government support.

He noted that in general advanced research on nuclear propulsion is "badly neglected," but he credited Argonne National Laboratory and NASA's Lewis Research Center and Marshall Space Flight Center with doing much of the important work on advanced concepts and mission analysis.

Placing nuclear propulsion in perspective relative to chemical systems, Schreiber stated that even with present technology we could perform the manned lunar landing and return with a nuclear stage in one launching, whereas an all-chemical system requires two launchings and an orbital rendezvous. ■

| System | Power Range | Weight Unshielded | Conversion | Design Life | Estimated Operational Date | Funding* Agency |
|---|---|---|---|---|---|---|
| **I. SOLAR** | | | | | | |
| 1. Solar Cells | 0 to 1 kw | ~ 1 watt lb. | Photo-Voltaic | Several Years | 1957 | NASA, Etc. |
| 2. Solar Collector | 100 to 250 watts | 5 watts/lb. | T/I | 1 yr. | — | Bendix |
| 3. Solar Collector | 1.5 to 15 kw | 5 watts/lb. | TU/E | 1 to 2 yr. | — | Bendix |
| 4. Solar Collector | 34 kw | 2300(1)<br>2800(2) | TU/E | 10,000 hrs. | — | AGN |
| 5. Sunflower I | 3 kw | 700 lbs. | TU/E | 1 yr. | — | NASA (TRW |
| 6. Solar Binary | 30 kw | 1800 lbs. | TU/E | 1 yr. | — | AF (TRW |
| (1)6000-Mile Orbit<br>(2)Synchronous Orbit | | | | | | |
| **II. CHEMICAL** | | | | | | |
| 1. $H_2O_2$ Fuel Cell | 900 watts | 83 lbs. | — | 1000 hrs. | — | TRW |
| 2. LI-$H_2$ Fuel Cell | 500 watts | 127 lbs. | — | 1 yr. | — | AF (TRW |
| 3. VORTEX MHD (Chem. Fuel) | 50 kw | 293 (incl. 150 lbs. fuel) | MHD | 60 mins. | — | TRW |
| **III. RADIOISOTOPE** | | | | | | |
| 1. SNAP 3 (Po-210) | 3 watts | 4 lbs. | T/E | 3 mos | 1960 | AEC (M-M |
| 2. Transit IV A and B (Pu-238) | 2.7 watts | 4.6 lbs. | T, E | 5 yrs. | 1961 | AEC (M-M) |
| 3. SNAP 9A (Pu-238) | 25 watts | 27 lbs. | T E | 5 yrs. | — | AEC (M-M) |
| 4. SNAP 11 (Cm-242) | 25 watts | 30 lbs. | T/E | 3 mos. | 1964 | AEC (M-M |
| 5. SNAP 13 (Cm-242) | 25 watts | 8 lbs. | T/I | Proof of Principle | | AEC (M-M) |
| 6. COMSAT (Sr-90) | 150 to 250 watts | 1+ watts/lb.(1) | T/E | > 5 yrs. | 1965 | M-M |
| 7. Radioisotope (Ce-144) | 500 watts | < 300 | T/I | 1 yr. | Study<br>1965 | AEC (M-M |
| (Cm-244) | | < 200 | | > 1 yr. | | |
| (1)High Temperature System | | | | | | |
| **IV. REACTOR** | | | | | | |
| 1. SNAP 10A | 500 watts | 525 lbs. | T/E | 1 yr. | 1964 | AEC (AI |
| 2. SNAP 2 | 2 kw | 865 lbs. | TU/E | 1 yr. | 1965 | AEC (AI) |
| 3. SNAP 8 | 30 kw | 1700 lbs. | TU/E | 10,000 hrs. | 1966 | AEC (AI) |
| 4. SNAP 8¹ | 60 kw | 2700 lbs. | TU/E | 10,000 hrs. | Feasibility Study | AEC-NASA (AI-AGN) |
| 5. STAR-R | 70 kw | 1400 lbs. | T/I | 1 yr. | — | GE |
| 6. START | 60 kw | 1000 lbs. | T/I | 1 yr. | — | M-M |
| 7. SPUR | 300 kw | 2800 lbs. | TU/E | 10,000 hrs. | Phase I Study | AF (AGN |
| 8. T/I REACTOR | 300 kw | 1200 lbs. | T/I | 1 yr. | Study | AEC (AI |
| 9. DCR-300 | 300 kw | 1900 lbs. | T/I | 1 yr. | — | M-M |
| 10. SNAP 50 | 100 kw to 1 mw | — | TU/E | — | ~ 1970 | AEC (PW |

*Listing of Company Indicates In-House Funding.

| | | | |
|---|---|---|---|
| AI | Atomics International | M-M | Martin Marietta |
| AGN | Aerojet-General | PW | Pratt & Whitney |
| GE | General Electric | TRW | Thompson Ramo Wooldridge |

(Note: This table is not complete; it represents submissions requested of participants.)

*Present systems lacking . . .*

# Command and Control Overhaul Due

## *Conferees find changing needs demand new emphasis on flexibility for military commander*

**By Michael Getler**

HOT SPRINGS, VA. — The United States has undertaken a new phase of development of its command and control systems—on both the national and military command level—to provide far greater real-time flexibility for the military command user.

Growing disenchantment with many highly automated C&C systems is causing a major shift in emphasis from hardware development to the so-called "software" aspects—the programs, procedures, language and man-machine relationships.

Assistant Air Force Secretary Brockway McMillan keynoted the shift at the First Congress on the Information Sciences, which met here late last month under the sponsorship of the AF's Electronics Systems Command and the Mitre Corp.

"It probably won't surprise you," McMillan told more than 250 assembled scientists and engineers, "but I don't think that the engineering of, specifically, military command and control systems is very highly developed."

McMillan quickly added that this was something that "nobody should be ashamed of." But he went on to say: "Because I think that this (military C&C) is a domain in which we have at best only a partial mastery of the engineering process, I am concerned that we may inadvertently ask too much of that process. I urge humility.

"Let's not try to design things which we don't fully understand; and, above all, let's not design too much into our systems. As far as I'm concerned, today a command and control system exists to support the commander, not to supplant him. This means that it must be flexible and responsive to his wishes; it must not conceal alternatives or make tacit assumptions; and, above all, it must not make commitments of which the commander is not aware."

There were few surprised faces in the audience. Later in the two-day session, several leading scientists voiced their own disappointment with several, generally unnamed, C&C systems.

• **Changing picture** — What form new systems will take, assuming new systems emerge, is not yet clear. But some facts have become apparent:

—Gains in development of hardware—high-speed computers, sensors, and communications equipment—have far outstripped the forward motion of the information sciences.

—It is much more difficult to effectively automate military C&C systems than was generally expected just a few years ago.

—Preoccupation with hardware, and emphasis on the system programer rather than the military user, has been compounded during the past two years by almost daily changes in the international political-military picture—and by rapidly evolving alterations in U.S. military policy. The latter revisions reflect the Kennedy Administration's stated requirement for a wider choice of military response than resort to nuclear war.

The move away from massive nuclear retaliation as necessarily the most favored or likely U.S. response has brought a crisis in command and control. The multiplication of intelligence and support data needed for all other alternatives and countermoves threatens, in the opinion of some observers, to swamp current C&C concepts.

Still other factors—vast increases in weapon yield and sophistication, improved reconnaissance inputs, shortened delivery and warning times—contribute to the growing feeling that even the most foresighted of yesterday's programs are inadequate.

It is now recognized that it is virtually impossible to freeze certain inputs to a C&C system months, perhaps years, before it is to be put into service. It is also clear that the military leader has vital experience and background for military decision-making, and that he must not be left out of the system. The C&C system must be made to support the military commander—to help him make the decisions, not to make them for him.

A fact also to be dealt with, fortunately in its largest sense, is that we have no real experience with nuclear wars of any type to call on in designing a system which must have information of immediate import to a commander during a conflict.

• **Flexibility goal**—There is now, and has been for some time, some form of national military command and control in the U.S. In recent years, it has been improved with gains in communications and data processing. But informed persons in this area point out that it must be even better to exercise the kind of control required to deal with complex military-political situations which can unfold with amazing lethality in minutes.

It must not be preprogramed to the extent that it cannot be rapidly changed. It must be geared to a wide range of selective response and must also be capable of aiding in evaluation of uncertainties which may develop with new weapons used for the first time in battle. It must be flexible to be effective, must be understood by the users, must allow for political and even legal considerations, and it must survive.

Above all else (it is stressed) it must be based on a firm understanding of military command doctrine and able to supply relevant information within the context of the user command.

To achieve this flexibility, if it can be had, C&C experts are turning attention away from computers and associated data-processing devices—already highly developed and sufficient for many new applications now being discussed—and will study an assortment of basic but critical problems.

This will include: a new and hard look at basic theory and doctrine of military command; an attempt to untangle an immense C&C language and semantic problem; applications, perhaps sooner than anticipated, of basic research in artificial intelligence; and a host of new programing schemes ranging from basically unprogramed computer tools to time-sharing methods.

• **Long row to hoe**—Now that the fog surrounding C&C has been officially recognized, it still is apt to be a long time before it is cleared away. This may mean great difficulty in starting expensive new systems.

Examination of C&C by the conferees here revealed that many are generally disappointed with several U.S. systems, either operational or still under development. Though the military sys-

tems took a critical beating in terms of their ability to react to realistic real-time situations, several observers went on record in defense of the military's use of this equipment, once delivered. They also pointed out, perhaps negatively, that the experience gained with these systems did at least serve to bring us to this point of re-examination.

The military, it was declared, had shown itself to be especially adroit in adapting formats to real problems, despite that fact that the system may have been programed much earlier by persons somewhat removed from the military.

The billion-dollar SAGE system, most often used as an example of what's happened with C&C systems, was generally assessed as effective, in a narrow sense, for what it was built to accomplish; it was conceded that these goals may have been short-sighted in view of the time period between concept and operation. Biggest disadvantage mentioned here was the system's vulnerability.

• **Doctrine lacking**—The congress also pointed up the considerable confusion which surrounds the basic information concepts about which effective C&C must be built. This basically involves determining which data are relevant and which are padding. To many, the lack of a basic doctrine here is critical. There is more than one expert who feels this will never come.

"We have been fascinated by the technology," asserts Dr. Clark C. Abt, manager of Raytheon's Strategic Studies Dept., "but we do not yet fully understand the command function with the result that we do not have a basic theory of military command. We must give more study to the commander. The theory of command itself is the central area."

Command and control is also suffering from a language problem which, unless rectified, could severely hamper further work in this area. The problem extends from computer program language to foggy definitions attached to discussion terms, to lack of an effective language with which military commanders can "talk" to a computer. There is also a critical problem in communication between information theorists and design engineers, apparently due to lack of fully understood concepts and terminology.

Clearer lines must be drawn between the types of C&C systems. There are distinct differences in the design requirements for intelligence systems, field command systems, and support networks such as logistics, procurement, and R&D.

Computer languages are being made more compatible than ever before, but several persons here asserted there is need for either better educating military



*AF's McMILLAN: Don't overdesign.*

commanders in use of computer language, or applying new languages—possibly straight English—to allow freer communication without fear of misunderstanding.

The communications problem also exists on other levels. To improve design, scientists must communicate with and understand the military. There are relatively few, in either the information sciences or the military, sufficiently well informed of both areas.

The classification problem also appears when information must be kept out of discussion areas which could lead to future system design.

• **The prod**—The signal for the increased activity now going into the information processing aspect of C&C came in June, when a Secretary of Defense memorandum was circulated throughout top levels of the defense establishment calling out areas of responsibility for the technical support of the national military C&C system.

Within key defense groups in this area—the Joint Chiefs of Staff, Director of Defense Research and Engineering, Defense Communications Agency and the armed services—there is expected to be a major buildup of in-house talent in this field. Whether or not the government can attract enough persons in an area where not too many are qualified remains a big question.

For the time being, some observers feel that this build-up within government may keep some work in-house rather than with industry. However, several industrial firms have put together considerable talent in this technology; they represent a formidable input not apt to be ignored.

• **Centralization** — In general, a DOD official noted, improved national C&C will come from improved systems all the way up the line from the field commander through the hierarchy of responsibility. For the near future, most observers here felt that greater flexibility for the user would be attempted by small additions and format changes of existing or soon-to-be available systems. This would also re-enforce a trend to centralization.

Most persons here privately conceded that the trend to centralize which has been associated with DOD management to date is also apt to apply to C&C systems. While this is good management for a lot of things, many feel it may not be suitable in the long run for C&C. Some see it as just the addition of more confusion to systems which are already disorderly.

The centralization issue was discussed in a paper by Dr. Norman C. Dalkey of the Rand Corp., who pointed to concentration during the past five years on: central nuclear war problems, partial "systems," hardware, vulnerability of communications and command posts, centralizing decisions in a few command centers, and information gathering systems.

"Due to long development times and the large sums involved in programed systems, we can expect these trends to resist modification," Dalkey said. "However, there are forces which will produce some major changes over the next five to ten years.

"The major force will be the shift in national strategic policy from a simple retaliatory posture for deterrence to a policy of flexible response. This policy will lead to greater emphasis on decision systems for types of conflict other than all-out nuclear war, and at the same time lead to requirements for extended C&C capability for central war.

"It is not possible to prepare contingency plans to meet the variety of potential conflicts inherent in the present, complex international situation. Techniques for rapidly adjusting to unforeseen conflicts will have to be developed. Undoubtedly this will require larger-capacity systems. Part of this increased capability will be met by increased automation for both data systems and weapons; part will be met by larger and more efficiently organized staffs."

"One of the first points where this force will be felt is vulnerability reduction," he continued. "However, the present emphasis on hardening and mobility as solutions to the vulnerability problem will run afoul of a simple fact of life," Dalkey said: "More and more complex functions cannot be crowded into smaller and smaller facilities.

"This constraint could lead to attempts to reduce vulnerability by techniques that are more integrally related to the structure of information systems; e.g., distributed communications, less centralized command, increased automation of lower-level functions. These modifications will be aided by the fact that in many cases they would afford positive improvements in command capabilities as well as increased survivability.

"Implementation of distributed communications and increased automation at lower levels of command will depend mainly on technical advances. Distributed command, however, runs counter to the trend toward centralization.

"Behind this trend are a variety of powerful motivations: The strategic problem does not neatly factor into subproblems. The significance of elementary events is large—one weapon can wipe out a city—and thus tight control by the highest, most responsible authority is indicated. In the present state of the art, centralization can produce significant gains in data-processing efficiency. More generally, commanders normally want as rich and complete control of forces under them as is feasible. On the other hand, there are serious drawbacks to radical centralization in addition to intensification of vulnerability.

"The burden of decision on the central command is increased," declared Dalkey. "Mistakes at the central level are amplified; overall flexibility is sacrificed. There will be a continuing attempt to balance these conflicting considerations, but I will hazard the estimate that for some years to come, the political advantages of centralization will outweigh the operational disadvantages.

"One further factor favoring centralization relates to coherency and the multiplication of separate 'systems.' The hazards involved in developing a large number of more or less independently designed information-handling structures was one of the earliest recognized problems in the C&C field. Originally known as the 'interface' problem, the difficulties are now recognized as being more profound than just compatibility of formats and communications.

One mode of approach to the problem of coherency is centralization. However, the approach is self-defeating if centralization merely means piling further separate structures on top of functionally uncoordinated subsystems.

"It would be pleasant to predict that the multiplication of separate systems is about to be reversed; however, the probability is that in the near future there will not be a significant change in this massive trend. The creation of a national military system will, for the time being, add one or possibly several new systems. Tying all the elements together into some kind of coherent structure will be a slow and painful process.

In the meantime, advances in weapons technology and richer interpretations of strategic doctrine will require new system elements. Operations in space, non-central conflicts, cooperation with a more self-sufficient European community, are some of the major perturbations that will be experienced shortly."

• **Two sets of needs**—Dr. Herbert Benington of Systems Development Corp. presented a paper outlining the significant differences in system needs for a policy of selective or controlled response—as opposed to the set-piece or spasm response which characterized U.S. thinking in the '50's.

Benington listed five salient functions:

1) More attack options must be provided to the senior decision-makers, and definition of these options involves both political and military considerations. Some of these options can be included in preprogramed war plans. Others must be drawn up while the battle is under way. Selective response aims for restraint, coercion, and negotiation.

2) Delay and restraint require survivability in a state of readiness possibly for days or weeks.

3) It may be essential to maintain the role of the presidency in addition to the office of commander-in-chief. Assessment, coercion, and negotiation will not be purely military. They may also involve political settlements of the crisis, or a detente on a broader scale.

4) Warning and reconnaissance must endure and function—allowing decision-makers to see what the enemy is doing, his and our successes, damages, and activity in other nations. During strategic exchanges, measures for arms control and inspection may become suddenly appealing for both sides.

5) We must be sensitive to the command arrangements of allies and the enemy.

This last area is expected to be of increased concern in the near future. Some scientists here called for increased government funding of studies of Soviet capabilities in C&C. Whether or not there is an advantage in a C&C "gap" is debatable. Ideally, many feel that the higher C&C is developed in both adversaries the better the chance for some sort of negotiated survival.

• **A prescription** — In his paper, Benington also sensed the disillusionment that many now feel towards application of technology in this area, and outlined his views on what we must learn if technology is to help the commander.

"First, I think we must learn much better to distinguish between those tools which can be developed outside of the operational command and the structuring of those tools within the user's organization under the user's choice and direction.

"For those tools developed outside the command—communication techniques, computers, consoles and programing languages—we should try to be much less command- or system-specific. We should ensure that a family of state-of-the-art elements is available to the user with known costs, proven reliability, and short lead times. Many of these components are already being developed by industry.

"Within the using command, we must develop a technical capability—an organizational resource—that will enable the command to perform several functions:

"First, to plan where the command might be going and to estimate where some early use of automated aids will help. In such a plan, we shouldn't allow grandiose notions—the opportunity of automated aids is often hypnotic. On the other hand, we shouldn't expect rigorous justifications of bandwidth, computer size, or numbers of consoles. We should expect a continuous experimentation on the part of the user to find out where the automated aids will help.

"Second, the user's technical capability should be strong enough to implement this plan—that is, to develop the communication formats, methods and procedures, organizational changes, command exercises, and computer programs, if any, which will turn these unstructured tools into an integrated subset of the command process.

"Third, the user should be capable of operating and evaluating this complex so that it meets the goal of a knowledgeable user managing a command whose realism and adaptiveness have been aided, not hindered, by technological aids.

"Provision of this technical support to the user is our biggest challenge. This support must be continuous—ad hoc groups won't help. It must be used and trusted—reporting at a low level or not being taken in on the command's private matters will soon vitiate the capability.

"And, equally important, it must be respected by the most technically qualified critics. There is too often a tendency when an operating command seems technically naive to reject their plans or to do their technical work for them. It would be more appropriate to help them help themselves." ⁂

# Technical Countdown

## ELECTRONICS

### Bonus Obtained from Alouette

Ionospheric data provided by Canada's *S-27* Topside Sounder *(Alouette)* include an unexpected bonus, according to John Jackson, project manager at Goddard Space Flight Center for NASA's role in the joint project. Principal goal was to obtain an ionospheric electron-density profile. However, the sounder also is very accurately measuring ambient conditions about the spacecraft resulting from "splash" phenomena—interactions that occur at several specific sounder frequencies that correspond to local plasma and gyro frequencies, and to harmonics of the fundamental splash frequencies. Measurements of these effects, says Jackson, will permit local electron-density and magnetic-field intensity determinations to within 1% accuracy.

### New Klystron Uses Lens Modulation

A longer-life and highly efficient high-frequency power amplifier now under laboratory test at Sperry Electronic Tube Div. makes use of a unique lens modulation technique. Actually a version of a klystron tube, the lens modulated oscillator uses a variable position electrode to control electron transit time between the first and second cavities. Located outside the electron beam (in the oscillator drift tube), the electrode does not draw current, and frequency modulation is achieved without changing oscillator power input. Also the lens electrode reduces cathode ion bombardment by pumping ions out of the beam, according to Sperry developers.

### Second MISTRAM Site Ready by '63

Subsystems are now being installed for the Air Force's new missile trajectory measurement (MISTRAM) site at Eleuthera Island in the Bahamas. Scheduled for operation early in 1963, the station will complement the previously completed station at Valkaria near Cape Canaveral. The system, developed by General Electric, is expected to permit a magnitude increase in determining missile trajectory and warhead impact prediction. The two MISTRAM stations will also be used to support future NASA manned space launches from the Cape, starting with *Gemini*.

### Spacetrack Growth Enormous

Since July 1961, the satellite population tracked by North American Air Defense Command's Combat Operations Center at Colorado Springs has expanded from 61 to 230, the Air Force reports. One observation is made roughly every 23 seconds and inputs to the center have increased from less than 20,000 in '61 to more than 150,000 a month today. The Spacetrack Center is operated by the 1st Aerospace Control Squadron, which has grown during this period from 12 to 121 men.

### Diode Temperature Characteristics Improved

A technique for "surface passivation" of Zener diodes to improve heat dissipation properties, low- and high-temperature storage capabilities, high-temperature operating specifications, and to minimize current leakage and low-level Zener impedance, will be used by Hoffman Electronics Corp. on commercially available diodes. The method involves oxidization of semiconductor junction edges to form a thin film of silicon dioxide. Passivation reportedly improves heat dissipation by 50%, extends low temperature storage limits to −196°C and high temperature limits to 250°C.

### Random Information Bits

Laboratory For Electronics, Inc., has demonstrated feasibility of a new differential scan recorder for time compression. Device shortens time-base reference by bringing time scales of non-repetitive phenomena within range of available measurement and analysis equipment. Recording medium is a thin, flexible, nickel-cobalt magnetic disk. . . . *The new IBM 7710 data communication unit permits data transmission between magnetic core memories of two IBM 1401 computers at all speeds (within limits of available broadband common carrier equipment) up to 5100 characters/sec. System will be useful in sharing computer workloads among widely separated ADP facilities.* . . . Antenna Systems, Inc., has produced a 30-ft. solid-surface dish antenna fabricated from interchangeable parts with static surface tolerances from 0.040 to 0.080 inch. . . . *Using a superconducting magnet for the applied field, Westinghouse has operated a millimeter-wave maser at 96 gigacycles. System was built for the Air Force in a study of high-frequency coherent microwave amplifiers for radar and space communications.*

## ADVANCED MATERIALS

### Phenolic Resins Withstand 5000° F.

A phenolic-silicone, 23-973 Plyophen (98-573), combining both the low orders of phenolic oxidation resistance and the high structural strength of silicones, will be marketed by Reichhold Chemicals, Inc. The improvement in hot strength exhibited by this resin indicates structural integrity will be improved where direct exposure to high temperatures causes surface char formation, say Reichhold experts. A second resin, phenolic-epoxy, is also available and both meet MIL-R-9299A.

### Russians Use Light to Accelerate Particles

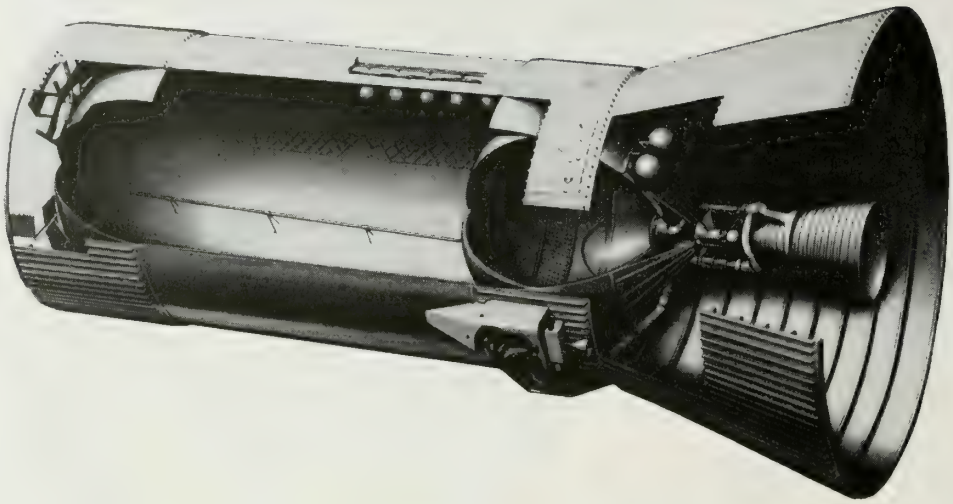
Professor A. Kolomenskiy and A. Lebedev are experimenting with the discovery that an intense beam of light directed along the axis of a long solenoid, through which an electric current is passing, accelerates charged particles in the path of the beam. An article in *Izvestia* covering the development suggests the effect may be used to develop new particle accelerators and also amplify radio waves of various bands.

### Olin Introduces New Copper Alloy

A copper-base alloy much stronger than copper but with moderately high electrical conductivity will be marketed by the Metals Div. of Olin Mathieson Chemical Corp. under the name Olin Brass No. 605. The alloy contains 2.3% Fe and 0.3% P and has a tensile strength in the annealed form 35% higher than electrolytic copper. Olin spokesmen claim the alloy will solve many problems of excessive heat rise in the manufacture of miniature electronic components.

### Tartar Throwaway Vehicle To Be Built

Hydro-Aire Div. of Crane Co. will build a disposable launch vehicle for testing the *Tartar* Mk-15 missile launcher. The expendable dummy will match the missile in all details. Contract calls for both prototype and production. All launch procedures, from magazine through firing, will be checked out with the dummy. The unit will be propelled by a solid motor but this aspect was not spelled out in the contract announcement.



*SATURN S-IVB will provide final surge of power for manned circumlunar flights.*

# Subsystem Kits Aid S-IVB Designers

***Varied mission requirements for Saturn stage prompted development of concept***

**by Russell Hawkes**

SANTA MONICA, CALIF.—A *Saturn S-IVB* design concept using special subsystem kits for different missions is expected to ease development of new versions of the stage. It is minimizing the new engineering required to adapt the stage to *Apollo* Lunar Orbit Rendezvous missions.

The *S-IVB* stage has a peculiar set of requirements in the *Saturn* programs. It is part of the launch vehicle, yet it is a spacecraft capable of controlled operations on orbital, lunar, and interplanetary flights. Because of its intermediate role between booster and payload, the *S-IVB* stage must be versatile if the *Saturn* system is to have the broad range of application it needs to justify its high development cost.

Adaptability to a wide variety of missions was assigned a high priority among the design requirements set by NASA when Douglas Aircraft Co. was awarded the contract to develop the 70-ft.-long liquid hydrogen-fueled stage from its smaller predecessor, the *S-IV*. Douglas engineers responded with the kit concept by which many subsystems and structural components are designed as factory-installed optional extras. Thus, when a new mission with new subsystem requirements is assigned, new kits can be designed or adapted with little change to the basic vehicle.

• **Kit concept explained**—Ted Gordon, *S-IVB* chief engineer, acknowledges that the term "kit concept" is a slight overstatement since it would usually prove difficult or impossible to retrofit a completed *S-IVB* with a different set of kit installations to prepare it for a mission different from its original one.

Some kit components must be selected before construction of the stage begins. The kit approach is not expected to make it possible to assemble a special-purpose vehicle from off-the-shelf components, but only to permit design of an *S-IVB* stage for a new application with a minimum of new engineering.

When NASA abandoned the Earth Orbit Rendezvous method of sending men to the Moon in favor of Lunar Orbit Rendezvous, Douglas had already done substantial preliminary design work on EOR kits. This work has stopped, but the Earth Orbit Rendezvous requirement is certain to be revived for future missions.

*Saturn* program engineers are confident that *S-IVB* kit development already will be usable when the time comes. Until then it will be unnecessary to develop techniques for remote checkout of the *S-IVB* while it is in orbit, rendezvous and docking techniques for the stage, or liquid-oxygen transfer techniques.

Among the *S-IVB* kits are special jet-reaction attitude controls designed with the attitude control system externally mounted so that a variety of installations could be used without affecting the design of the rest of the vehicle.

If the stage must be maneuvered when it is heavily loaded, the attitude-control jets selected have more thrust than those selected to maneuver a lightly loaded one. Propellant tanks are sized according to the length of the mission. All the attitude-control kits burn the storable hypergolic combination of hydrazine and nitrogen tetroxide.

• **Interface problems**—Some structural components are designed as kits. The *S-IVB* will mate with a variety of lower stages and payloads, so interstage structures must differ according to the mission. In the *C-5* configuration, the interstage structure must join the 260-in. diameter *S-IVB* to the 396-in. *S-IB*. As part of the *C-1B* booster combination it must mate with the 260-in. *S-I* lower stage. Strength and weight of the interstages is also mission-variable.

As part of the *Saturn C-1B* launch system, the stage has a role in the

*Apollo* orbital flight tests in preparation for the actual lunar landing program. The *C-1B* can also be used to power lunar supply vehicles, and will perform other missions in support of the *Apollo* program.

In the Lunar Orbit Rendezvous mission for which the *Apollo-Saturn* combination is now being designed, only one *C-5* booster system will have to be launched compared to two or more for the EOR mode. Since it is not certain how much time will have to elapse between *C-5* launches, NASA and Douglas engineers assumed that it might be necessary for the first vehicle launched to remain in orbit for several weeks before rendezvous.

In the LOR plan, the *S-IVB* flies a dual-burn mission. It helps launch the *Apollo* system into a brief parking orbit, then re-ignites to inject the payload into its lunar transfer orbit. After the end of the second burn, the *S-IVB* attitude-control system is used to stabilize the assembled Command, Service and Lunar Excursion modules while the LEM is placed atop the Command Module so that its two-man crew can enter it.

The launch position of the LEM is between the top of the *S-IVB* and the bottom of the Service Module. The turnaround is accomplished by lifting the assembled Command and Service modules off the LEM with a pair of extendable arms mounted on the *S-IVB*, pivoting the assembly 180°, and bringing it back so that the narrow end of the Command Module can be connected to the LEM. The *S-IVB* is then separated from the *Apollo* modules, and its job is ended.

• **LOR allows simplification** — NASA's switch to LOR has greatly simplified the development of the *S-IVB* for *Apollo*, since EOR called for a number of kit additions to meet very stringent requirements associated with rendezvous, docking, long-term storage of liquid hydrogen in space, propellant transfer, and remote checkout of the stage from ground stations.

Two EOR mission modes were considered: the connecting mode and the tanking mode. The former required an *S-IVB* fully loaded with propellants to be orbited by one *C-5* launch vehicle followed by a second *C-5* launch to send the *Apollo* payload into a companion orbit. After a rendezvous and docking maneuver, the *S-IVB* was to provide orbit escape velocity for the *Apollo*.

In the tanking mode, a liquid oxygen tanker was to be launched into a waiting orbit, and a second *C-5* launch would orbit the *Apollo* and an *S-IVB* carrying only liquid hydrogen. The tanker was then to move into the *Apollo* orbit. After rendezvous and docking, liquid oxygen would be transferred from the tanker to the *S-IVB*, the tanker would be staged and the *S-IVB* would propel the *Apollo* modules into their lunar transfer orbit.

The tanking mode reduced the problems of long-term hydrogen storage, attitude control, and power supply to about the same proportions as the LOR flight plan, but it introduced the necessity to develop liquid oxygen transfer techniques for use in space.

Propellant storage is not entirely escaped in the tanking mode but only transferred to the tanker development program and lessened somewhat because liquid oxygen is easier to store than hydrogen.

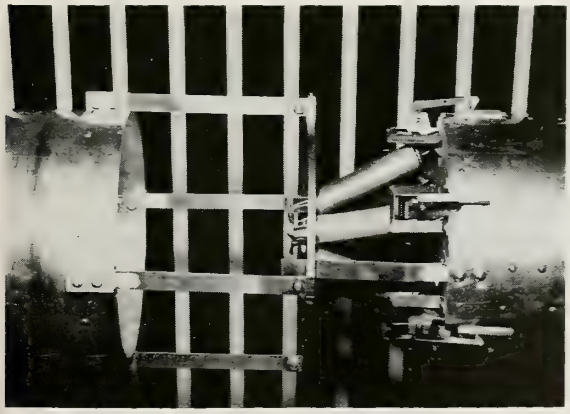
These mission profiles or variations of them will be used when the need for Earth Orbit Rendezvous reappears. Before development of *S-IVB* kits for these was terminated, Douglas had completed preliminary design and had tested a docking structure that was similar in principle to the one that would have been used in Project *Apollo*. The tests were conducted by suspending dynamic models of the chaser and target vehicles as pendulums and letting them swing together at a speed simulating the 10 fps impact velocity expected in the actual maneuver.

• **Docking Details**—The female docking structure is a simple ring held away from the end of the vehicle. The male structure is a smaller ring on the ends of guide rails angled inward like teepee poles from the circumference of the vehicle, forming a conical guide structure. At the base of this is a ring of "snubber-grabber" carriages with strong, spring-loaded traps to grasp the ring of the female structure, and claw-shaped pawls which are driven down ratchet tracks by the docking impact. The ratchets prevent rebound.

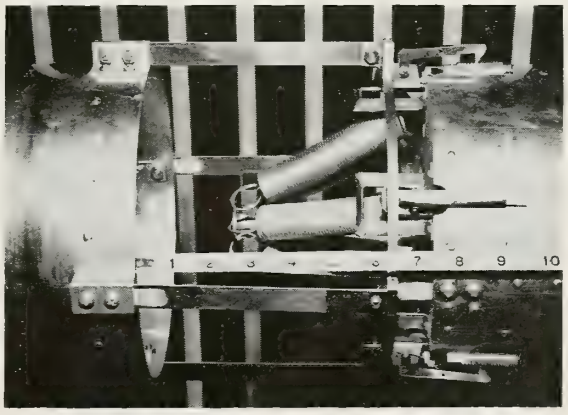
The pendulum tests indicated that the snubber-grabbers could be strong enough to bear attitude maneuver loads on the jointed vehicles. At the time the EOR *Apollo* mission profile was abandoned, no decision had been reached about which vehicle would carry the male structure and which the female.

Micrometeorite protection and prevention of excessive hydrogen boil-off are problems in the prolonged storage of liquid hydrogen in orbit. There is an inverse relationship between storage time and payload because of boil-off. To minimize boil-off, solar heating must be minimized. Douglas designers plan to use a lightweight single shield both for thermal control and as a micrometeorite bumper that could be jettisoned after rendezvous and before starting the lunar transfer orbit.

Unlike *Centaur*, the basic insulation of the *S-IVB* is inside the tanks and is a permanent part of the structure. The additional combined solar insulator and micrometeorite shield was to be mounted outside and was to be separated from the skin of the stage by a gap. Detailed design of the shield was not begun, but it is expected to be made out of multi-layer materials or honeycomb. ⁂



*RING OF FEMALE docking structure slides down guide rails toward waiting snubber-grabbers in simulated 10-fps docking.*




*DOCKED MODELS show female ring trapped by snubber-grabbers, which are prevented from rebounding by ratchets.*

# Improved ARCAS Aids Antarctic Researchers

***Modified fin-bonding techniques and better quality controls eliminate problems plaguing past efforts***

**by Tom Kilpatrick**



*LEAVING behind follower piston and styrofoam spacers that keep it positioned in its launcher, ARCAS soars over McMurdo Station in the Antarctic to glean high-altitude wind and temperature data.*

RECENT MODIFICATION of Atlantic Research Corp.'s *ARCAS* sounding rocket has significantly increased chances of overall success in the first Antarctic-based upper-atmosphere research rocket program.

The National Science Foundation, which sponsors U.S. Antarctic research, has announced that modified *ARCAS* rockets recently shipped to the South Pole are performing consistently well in the Antarctic spring series of research rocket shots. The program is funded by the Foundation and conducted by Schellenger Research Laboratories of Texas Western College. The grant for the program in Fiscal 1963 totals $208,000.

The success to date of the current series is in sharp contrast to reports of only partially successful efforts during the winter season, when temperatures ranged low as −80°F and high winds plagued launch operations.

• **The ARCAS gremlin**—But the problem, despite severe conditions, was not the weather alone. A major gremlin was discovered in the 96-in. solid-fuel *ARCAS* itself.

The *ARCAS* is stabilized by fins bonded to its body and slightly offset to induce a slow roll in the vehicle during flight. It was discovered that under certain conditions aerodynamic cross-coupling produced a flat spin that increased drag on the *ARCAS* and consequently reduced the altitude achieved.

Spin tabs introduced to increase roll rate also brought increased failure rates, which were traced to fin breakaway during powered ascent.

Further inspection indicated that materials used in bonding the fins to the body of the rocket were marginal under extremes of motor and aerodynamic heating.

New bonding materials and techniques and new quality controls introduced in time for the latest *ARCAS* shipment to the South Pole may have made the difference between early failures and later success, an ARC spokesman said.

• **Network hardware**—The *ARCAS* (all-purpose rocket for collection of atmospheric sounding) is now key hardware for an informal atmospheric weather data network spread across the nation and extending beyond the continental U.S.

Though the space agency has spoken for several years of making the network an official one, no such action has been taken. Lack of funds is the reason most often given for the delay. Reportedly, the Air Force has become so impatient to see the network formalized that it is planning action of its own.

The rocket originally was developed with military funds—through the Office of Naval Research, the AF Cambridge Research Laboratories and the Army Signal Missile Support Agency. Added support of *ARCAS* development was later provided by NASA, as well as by other military research groups.

The rocket has been used routinely since 1959 for meteorological data-gathering, missile-support operations and high-altitude experimentation. More than 1000 *ARCAS* rockets have been flown successfully from land and shipboard sites around the world.

They have been used to provide pre- and post-flight weather data in support of many major space flights, manned and unmanned, and have provided similar support for *X-15* research tests.

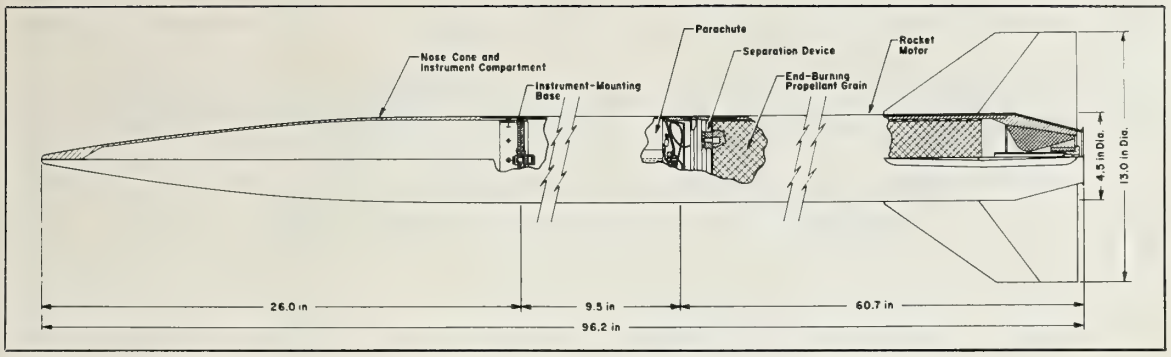
An *ARCAS* system now operative on Ascension Island has produced fully successful shots to 230,000 ft., and a similar system is being set up on Antigua Island by AF and Pan American weather groups.

Four missile-tracking ships for the Atlantic Missile Range soon are to be equipped with *ARCAS*, and full MIL-qualification tests of the rocket are now under way. An ARC spokesman said that the tests, to be completed in December, are expected to show *ARCAS* capable of functioning under extreme temperatures ranging from −50° to 130°F.

• **Motor for ARCAS**—The rocket motor powering *ARCAS* is loaded with Arcite—a stable, high-impulse solid propellant of end-burning grain geometry. The motor assembly weighs 65 lbs. It provides 336 lbs. of thrust and chamber pressure of 1020 psi, with nozzle expansion ratio of 13:1.

The motor assembly measures about 60.9 in. long by 4.5 in. in diameter.

*ARCAS* motor action time is 29 sec., and a standardized delay train is designed to pinpoint pyrotechnic separation of the payload from the motor 100




*IDEALIZED DRAWING gives impression of elements in assembled ARCAS sounding rocket.*

sec. after ignition, at apogee. Delay can be modified for special applications.

A data-transmitting payload is carried from apogee to Earth by a 15-ft.-dia. parachute. Though the parachute is metalized to facilitate radar tracking, the Antarctic research team uses AN/GMD-1 radio gear only, employing triangulation techniques to establish a fix between two ground stations.

• **Launching system**—ARC is particularly proud of its closed-breech launcher, used to fire *ARCAS* and other sounding rockets. The launch system requires only a short countdown and a minimum of manpower.

The rocket, positioned in the launcher by styrofoam spacers, rests on a piston that provides a gas seal with the walls of the launching tube. Exhaust gases from the burning rocket are thus trapped and used to accelerate the rocket along the 20-ft. tube at rates five times what they would be without use of the closed breech.

For even higher launching velocities, a mechanically actuated auxiliary gas generator may be used to augment the gas pressure. Easily installed in the free-volume launch cylinder, the generator uses a standard seat-ejector cartridge as a gas source.

• **Problems with progress** — While ARC's fin-bonding modifications for *ARCAS* may have solved a problem that plagued rocket technicians in the Antarctic and may promise greater success for other buyers of the sounding rocket, Canaveral and other sites have a fairly large inventory of the original vehicles that ARC concedes may be marginal in some situations.

In addition, at least one parachute failure with the older rocket was reported at Canaveral recently. This may also be corrected by the newer version.

Atlantic is working on these problems, in addition to undertaking further *ARCAS* development.

ARC has increased the rocket's altitude capability by adding a relatively inexpensive booster. The boosted *ARCAS*, now operational, has been flown to heights of more than 330,000 ft., and consistent achievement of 460,000 ft. is promised.

The standard *ARCAS* launcher, with only minor modifications, is used for the boosted *ARCAS*.

The firm also is developing a completely frangible case for the *ARCAS* rocket motor. Upon separation, the plastic case would be pulverized—eliminating fallout and making possible safe flights over other than established missile ranges.

Another development project under way is the *Sidewinder-ARCAS*. As the *Sidewinder* is available to some programs without cost on a GFE basis, a *Sidewinder*-boosted *ARCAS* would carry a 10-lb.-plus payload well above 400,000 ft. at a cost of about $2000, Atlantic Research says.

While upper-atmosphere wind profiles are determined by tracking the descending *ARCAS* payload, temperature information is transmitted directly to ground stations. The temperature sensor uses a miniature bead (spherical) thermistor measuring only 0.010 in. in diameter.

Though wind and temperature are the only sensors used in the Antarctic program, ARC says it now has available or is doing development work on sensors for density, pressure, ozone and atomic oxygen.

James Bettle, research engineer for Texas Western College's Schellenger Laboratories and leader of the rocket program in the Antarctic, says present knowledge of high-altitude air temperatures and wind profiles in the high southern latitudes is largely theoretical.

During the Antarctic winter, ozone formed in the upper atmosphere reaches the surface of the icebound continent from the North, demonstrating existence of southbound winds aloft, Bettle says. Though computations have been made to predict the values of these winds, researchers in Antarctica say they need frequent systematic measurements made simultaneously with similar measurements over other regions of the Earth.

Bettle believes that the South Pole *ARCAS* shots will produce such data.

Another phenomenon that scientists believe the rocket shots may help to explain is the sudden warming period that occurs each Antarctic spring, but is not matched by a similarly rapid cooling period in the fall.

During the warming period, high-altitude temperatures may rise to about −45°F over a period of a few days, after a consistent winter temperature of about −80°F. ⌗



*LAUNCHER TUBE is raised from insulated cradle after rocket is loaded. Closed-breech principle uses rocket exhaust to multiply boost five times. Firing is by remote control from another building, and requires a short countdown. (NSF photo by Jack Renirie)*

# TVC Position Errors Eliminated

## *Moog development may find application in systems involving swiveling of engines in liquid rockets*

**by William J. Thayer**
*Manager, Design & Development*
*Moog Servocontrols, Inc.*
*East Aurora, N.Y.*

A NEW PRESSURE feedback servoactuator configuration may find increasing use in thrust-vector control systems involving the swiveling of engines in liquid rockets.

Developed by Moog Servocontrols, Inc., the Static Load Error Washout (SLEW) system completely eliminates engine static position errors caused by compliance of both the servoactuator and the vehicle structure.

Swiveling engines for TVC of a missile or space booster is a well-established steering approach. Electrohydraulic servoactuators are normally used in these systems when the engine inertia exceeds 50 slug-ft.$^2$, since these actuators can produce high control power per package weight and have good dynamic response capability. In a typical two-engine vehicle, two actuators would be used on each engine to provide pitch, yaw and roll control.

An inherent problem arises in all larger-engine vehicles because of the very pronounced resonance created by engine inertia and compliance of the gimbal and actuator support structure. In a typical system, this resonance may occur at frequencies between 7 and 15 cps, and have an amplitude ratio as high as 20 db (equivalent damping ratio of 0.05). This load resonance presents a severe stability problem for the engine position-control actuators.

• **Dodging resonance** — An early solution to this engine resonance problem consisted of adding a bypass orifice across the piston control lines.

This orifice passes flow when engine-inertia reaction forces are present, and reduces the actuator velocity creating a damping effect. Unfortunately, the bypass orifice method has several basic disadvantages:

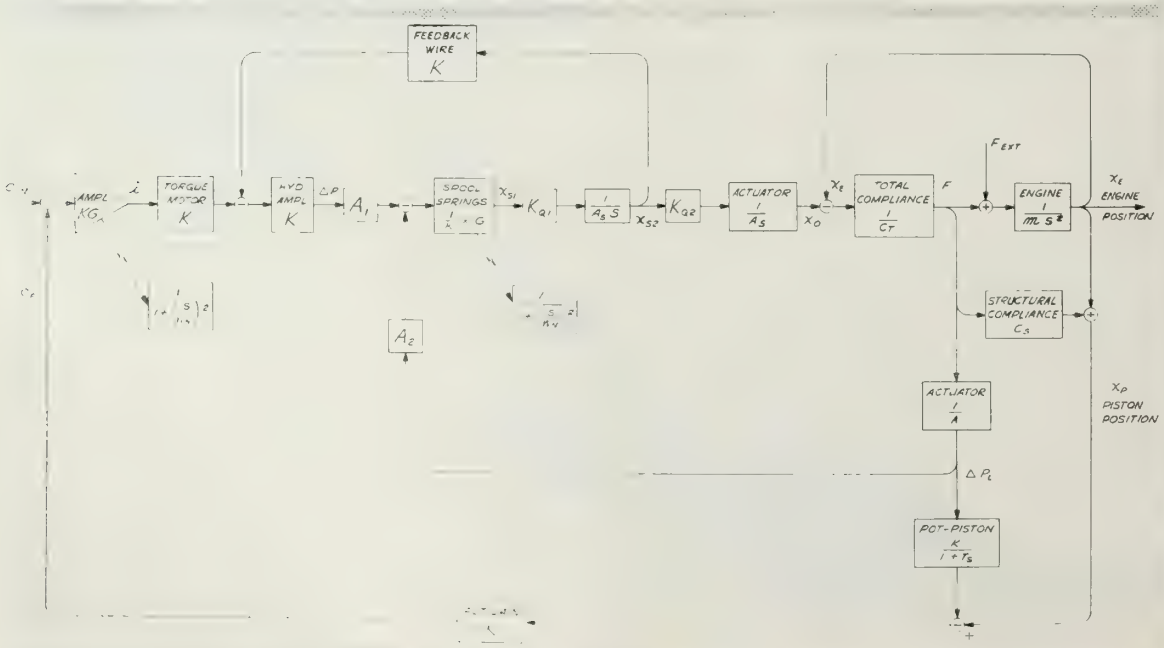
—There is appreciable bypass flow present when the actuator is holding against a steady load (as with a constant engine deflection, or with engine thrust misalignment through the gimbal, or with steady vehicle accelerations).

—And bypass flow due to steady loads or due to dissipation of the engine's resonant energy may cause severe heating of the oil and actuator.

—In the presence of a steady load, the servoactuator will displace by an amount sufficient to produce the servovalve current needed to support the bypass flow.

—The basic nonlinearity of sharp-edged orifices allows bypass flow at essentially zero pressure drop, so actuator null accuracy is destroyed.

All of these phenomena result in poor actuator efficiency, higher power supply requirements, poor actuator accuracy, and secondary problems caused




*SYSTEM DIAGRAM incorporating the SLEW actuator.*

by temperature rise in the actuator components.

A significant improvement over the bypass flow approach came with introduction of the pressure-feedback or PQ valve. Early work on various types of pressure-feedback flow control valves is attributed to W. B. Lloyd of the Westinghouse Electric Corp.

In a PQ servovalve, the load-pressure differential is internally fed back to give a proportional reduction of load flow. This pressure-flow relationship is analogous to a load-force-velocity effect, contributing damping control for the engine resonance.

With the pressure feedback, as opposed to bypass flow, there is no steady flow through the valve when the piston is holding a load. Instead, an error signal developed in the position servoloop acts to cancel the pressure-feedback effect.

This error signal is developed by displacement of the actuator piston away from the desired position, and constitutes a loss of static accuracy under load. However, a system with a PQ valve eliminates the power wastefulness of bypass flow and also avoids the severe loss in null accuracy caused by bypass orifice nonlinearity.

The loss of accuracy from actuator displacement under load is identical to the change of engine position permitted by compliance of the vehicle structure. Unfortunately, the only practical location for the system-position feedback transducer is at the actuator, so the position error caused by structural compliance acts entirely outside the loop. The total engine loading error then represents the combination of the actuator and structural compliances acting in series.

The magnitude of the actuator compliance depends directly on the ratio of the pressure loop gain to the position loop gain. The latter gain is normally set as high as possible, consistent with actuator stability considerations. This usually gives a value of about

$$K_{vx} = \frac{\omega_n}{3}$$

where

$K_{vx}$ = position loop gain, sec$^{-1}$

$\omega_n$ = engine resonant frequency, rad/sec

The pressure loop gain is set to give adequate load damping, and usually has a value of about

$$K_{vp} = \tfrac{2}{3}\ \omega_n \text{ sec}^{-1}$$

The actuator compliance is approximately

$$c_a = \left(\frac{K_{vp}}{K_{vx}}\right) c_s = 2\ c_s$$

where

$C_a$ = servoactuator compliance, in./lb.

$C_s$ = equivalent structural compliance, in./lb.

So the combination of the actuator and structure will present a compliance of about three times the physical compliance of the system. The error in engine swivel angle associated with this combined compliance effect normally ranges from 10 to 40% of maximum engine-control angle under full load—a very significant system inaccuracy.

• **Present solutions** — An attractive approach for eliminating some of this static positioning error is to use a Dynamic Pressure Feedback (DPF) servovalve. Pressure feedback is needed only for damping of the engine resonance, whereas the loss of actuator accuracy with pressure feedback is a static effect.

Insertion of a hydraulic high-pass filter in the pressure feedback path can wash out the static pressure feedbacks, but pass the dynamic pressure variations associated with the load resonance. This washout will eliminate the portion of the total engine error caused by actuator compliance.

In either the dynamic pressure feedback or dynamic flow bypass schemes, an additional mechanism is added to wash out the flow-to-pressure relationship for static conditions. This washout eliminates static position errors caused by actuator compliance, but does nothing to compensate for errors resulting from structural compliance. In typical systems, structural compliance errors may range from four to 15% of full engine angle with rated load conditions. The new SLEW configuration eliminates even these structural errors.

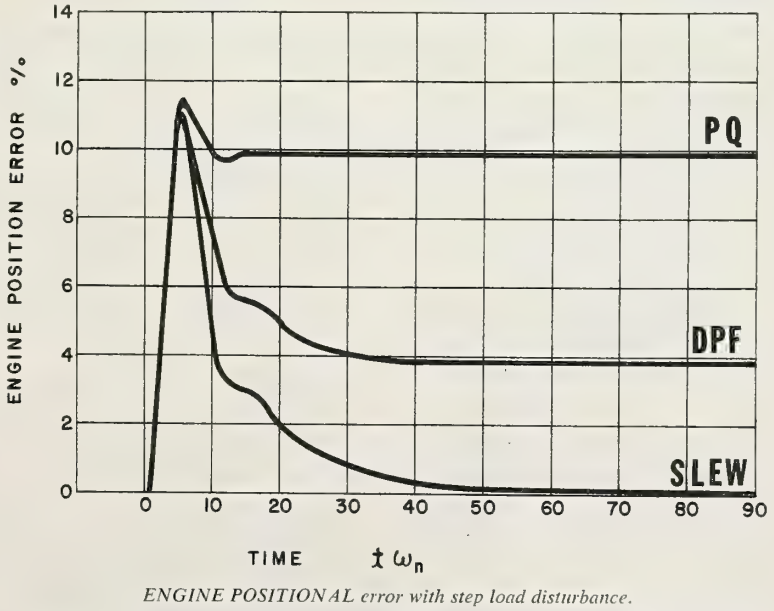
Basically, SLEW is achieved by combining a proportional pressure feedback (PQ) in parallel with a low-pass pressure feedback having the opposite polarity. With dynamic load pressure variations, the parallel SLEW feedback path produces little output, so normal pressure feedback is present for damping of the load resonance. Statically, however, the parallel feedback acts to cancel the PQ effect.

If exact cancellations were designed into the system, the SLEW configuration would be equivalent to DPF control. However, by increasing the gain of the parallel feedback, further washout occurs, which may be set to cancel errors caused by structural compliance.

Mechanization for SLEW can be incorporated entirely within the servovalve, or may be accomplished in other ways. An attractive approach for a very large servoactuator is to package the SLEW mechanism within the actuator piston.

Here a conventional stub-shaft spool PQ valve can be used for normal pressure feedback. With a large actuator, this may be a three-stage flow-control valve. The parallel pressure feedback for SLEW can then be summed at the actuator position feedback transduced by a load-sensing piston that is carried within the actuator piston. Any number of equivalent mechanical, hydraulic or electrical combinations of the two pressure feedbacks could be used for the same functional result.

Potential failures of the mechanism are orifice clogging or stoppage of the spring-centered piston. In either event, pressure feedback is lost in conventional systems. With SLEW, the system retains pressure feedback for load stabilization while losing only the error washout capability. ⁂




*ENGINE POSITIONAL error with step load disturbance.*

# Simplicity Is Key to Cobra Missile

***European nations buying antitank weapon which is believed to sell for about $600***

**by Anthony Vandyk**

MUNICH, GERMANY—Production of more than 30,000 *Cobra* antitank missiles has established Boelkow Entwicklungen as one of Europe's most important manufacturers of guided weapons.

The company, founded in 1956, now has over 2000 technical personnel. Close to 90% of its work is for the German Defense Department.

To date, only Germany and Denmark have bought *Cobra*. But orders from Italy and several other European nations are in an advanced stage of negotiation. The U.S. Marines and Army also have evaluated *Cobra*.

Boelkow is not permitted by the German government to sell to countries other than those in alliance with the West, although several of these have expressed an interest in the antitank weapon.

There are three reasons for the increasing interest that *Cobra* is arousing at this time, Boelkow points out. It is light in weight, simple and cheap. Boelkow is not prepared to state the price—but it is believed to be around $600.

Essentially a one-man weapon for infantry combat, *Cobra* is so light that two missiles and the requisite ground equipment can be carried by one man, if necessary. The weight of one missile and one control box is only 31 lbs.; two missiles and one control box have a total weight of only 53 lbs.

*Cobra's* light weight was made possible by use of plastic for fuselage, wings and container. Another weight-saver is elimination of a launcher. The missile is launched directly from the ground with the nozzle of the booster rocker positioned at an angle to the ground so that *Cobra* is lifted by means of forces released by the rocket.

• **Accent on simplicity**—Electronic circuitry in the flight vehicle, necessary to receive the guidance signals from the command box, has been reduced to minimum size. For the stabilization of the flight vehicle about its longitudinal axis, a gyro is used. This gyro is activated in the simplest manner—by a string. A lanyard is wound in a groove of the rotor. The end of the lanyard is



*WEST GERMAN infantryman carries new Cobra weapon system.*

combined with the two signal wires, which together end in the anchor cable. This anchor cable is rolled up in the inner portion of the rear-end cover.

When *Cobra* is prepared for firing, this cover with the proper connecting cable (rocket cable) is pulled off. The anchor cable can then be fastened to a fixed point (for example, hooked to the anchor peg, which is supplied with the rocket). The gyro lanyard brings the rotor to a rotational speed of 12,000 rpm as a result of the launch velocity. This rotational speed is sufficient to assure the function of the gyro during the entire flight.

The sustainer rocket is centrally located within the flight vehicle. Around it is wound the signal wire spool. A battery fitted in the missile serves as power supply for the electrical power requirements of the flight vehicle.

Located in the trailing edge of each of the wings is a spoiler assembly, in which two electromagnets are alternately energized by the guidance signals, the spoiler blade being attracted to the magnet that is energized.

Design of *Cobra's* warhead is intended to assure high reliability and safety for the operator. The nose fuze functions at incident angles to the armor plate from 15 deg. up, but only then when the impact is greater than that of a free fall from a height of 16½ ft. on a steel plate. A shaped-charge effect, however, is possible only when the *Cobra* has flown a distance of more than 820 ft.

This is achieved by a shutter which blocks the path of the ignition jet from the nose fuze to the detonating charge of the shaped charge, and which releases only after the acceleration has acted upon a delay mechanism for a predetermined time. The mechanism then rotates the shutter out of the path of the ignition jet. For practice firings, the warhead is exchanged for an inert training head.

• **Potency**—Boelkow officials point out that it is not only the size of the entry or exit hole in the armor plate or the depth of penetration which is decisive for judging the effect of the warhead—it is obvious that the size of the holes is proportional to the size of the explosive charge.

Numerous tests by the German Army have shown that the effect of the hollow charge of *Cobra* is sufficient to pierce armor plates of all existing tanks, even under unfavorable impact angles. Moreover, tests showed that damage was sufficient to put the tank out of action, destroy its ammunition, or kill the crew inside the tank, either directly or by the effect of splinters.

Ground support equipment for *Cobra* consists of a command box, the 72-ft. connection cable of the missile, and the cables with the junction box. For the first time, the mechanical command and its transformation into electrical commands as well as the necessary power supply are combined in a single device.

A distributor strip with eight connectors and a 160-ft. distributor cable makes it possible to connect eight Cobras to a single command box, at up

# Russians Report Cutback Of 30% in Rocket Probes

THE USSR says it launched only 115 research rockets during 1961—45 fewer than it reported firing during 1960.

The new figure, disclosed in an official report to the Committee on Space Research (COSPAR), signifies a reduction of almost 30% in research activities using probes.

While the launching sites remain about the same (1—Franz-Josef Land, 2—Middle Latitudes of European USSR and 3—Expedition ships in the Pacific), the biggest cutback has been in the Pacific and in the European USSR area.

There were no 1961 launchings in the Black Sea, which suggests that the 1960 rocket test ship Shokalsky has since joined the Pacific rocket test ship Voyeikov, which the Russians admit has been launching rockets there since Jan. 17, 1960.

• **Clampdown**—With the exception of four experiments, the USSR Academy of Sciences was not permitted to disclose exact dates and times of each launching—as was done for the Jan.-June, 1960, period.

In that singular report, the Soviet scientists themselves pin-pointed the Franz-Josef Land launch site at 80° 37′ N, 58° 03′ E on Heiss Island, a favorite Academy research preserve since its discovery by the Payer-Weyprecht Expedition in 1873.

Nothing in the new report supports the notion that the Russians normally step up activities with probes prior to major manned space attempts—although this seems to be the case for new unmanned space efforts such as the Venus probe.

The details provided for the first half of 1960 indicated at that time that there was a heavy concentration of research rocket launchings up to a few minutes prior to a major space effort. The new report seems to support this analysis.

For example, on March 9, 1961, the capsule containing a dog named Chernushka was orbited and successfully recovered. Later, on March 25, a second capsule with a dog called Zuyozdochka was also orbited and recovered. Yet only three research probes were reported for that month.

Shortly thereafter, on April 12, cosmonaut Y. A. Gagarin made his successful pioneer flight. Only four rocket experiments, all in the Pacific, occurred that month.

There were no rocket experiments in August when cosmonaut H. S. Titov put in some 25 hrs., 18 mins. of space flight.

On the other hand, there were 25 launchings in February, when the Soviets put up two unmanned satellites involved in their Venus probe program. The first was orbited on Feb. 4 to check out precise trajectory measurements and reliability, an indispensible exercise on which the success of the Venus probe was predicated.

On Feb. 12, the second, from which the 1415.7-lb. Venus-bound vehicle was released, was put into a 13-day orbit.

Of those experiments in 1961 whose actual launch dates are provided, two occurred during the total solar eclipse of Feb. 15.

The Russian report to COSPAR also singled out the lone shots in September and in November from European USSR as special experiments for "complex investigations of the upper atmosphere."

The first "special", which took place on Sept. 23, reached 62 miles altitude; the second reached 267 miles on Nov. 15. ⠿

TABLE I

Soviet launchings of research rockets for period of Jan. 1 to Dec. 31, 1961, as reported to COSPAR

| MONTH | PLACE OF LAUNCHING | | | TOTAL |
|---|---|---|---|---|
| | Franz-Josef Land | European USSR | Pacific | |
| January | 8 | 0 | 18 | 26 |
| February | 11 | 14 | 0 | 25 |
| March | 0 | 3 | 0 | 3 |
| April | 0 | 0 | 4 | 4 |
| May | 1 | 0 | 8 | 9 |
| June | 9 | 0 | 13 | 22 |
| July | 11 | 0 | 0 | 11 |
| August | 0 | 0 | 0 | 0 |
| September | 0 | 1 | 0 | 1 |
| October | 4 | 0 | 0 | 4 |
| November | 0 | 1 | 0 | 1 |
| December | 9 | 0 | 0 | 9 |
| TOTAL | 53 | 19 | 43 | 115 |

TABLE II

Comparison of Soviet research rocket launchings: 1960 and 1961

| | Franz-Josef Land | European USSR | Black Sea Ship | Pacific Ships | Total |
|---|---|---|---|---|---|
| 1960 | 54 | 34 | 5 | 67 | 160 |
| 1961 | 53 | 19 | 0 | 43 | 115 |

to 230-ft. distance. This can be extended to 390 ft. by means of another 160-ft. distributor cable. A selector switch on the command box permits firing of the missiles in any desired sequence.

Although the reliability of *Cobra* is now guaranteed at 95%, Boelkow is constantly trying to improve its product. Likening it to a Volkswagen, officials of the German company note that although the missile has not changed externally in the four years that it has been in production, there have been many minor improvements. The latest of these will increase *Cobra's* range to 6000 ft.

*Cobra* will soon be entirely manufactured by Boelkow. Originally Switzerland's Oerlikon/Contraves helped in the design. In the past the booster and sustainer rockets as well as the warhead have been supplied by the Swiss company. However, from early next year Boelkow will make these items at the Schrobenhausen plant, where the *Cobra* assembly line is located. The main part of *Cobra*, including fuselage, wings and electrical items, is manufactured at the Nabern plant.

Although *Cobra* production is likely to continue for several more years, Boelkow is well advanced with the design of an even more sophisticated antitank weapon. This program is being carried out in cooperation with France's Nord-Aviation, which makes the *SS-11* and *Entac*. ⠿

# Surveyor Ground Network Is Complex

LOS ANGELES—The low degree of automation in NASA's *Surveyor*—the result of a design philosophy that complex ground equipment is tolerable if it produces simplicity in the spacecraft—has given the ground electronic network an unusually large role in operations.

J. S. Green of Hughes Aircraft Co., prime contractor for the *Surveyor* unmanned lunar landing system, outlined the network's job at the recent West Coast annual meeting of the American Rocket Society here.

The Command and Data Handling Console (CDC) will command nearly every action of the spacecraft by signals transmitted from the stations of the Deep Space Instrumentation Facility (DSIF) operated for NASA by Jet Propulsion Laboratory, Green said. The only fully automatic action of the spacecraft is its lunar landing sequence.

There are two classes of ground operations—trajectory determination and vehicle control. The first is conducted by the JPL Space Flight Operations Center at Pasadena, Calif., with data supplied by the DSIF stations at Goldstone, Calif., Johannesburg, South Africa, and Woomera, Australia.

Control operations are conducted by CDC operators at the DSIF stations under general direction of the SFOC. The operators will execute pre-planned sequences and orders from the SFOC, and may take some actions on the basis of their own analysis.

• **Reliability**—Obviously, reliability of the CDC and error-free performance by its operators are essential to mission success. Hughes engineers are providing a high degree of insurance that these conditions will be present. Reliability-improving aspects of design include:

—On-line spares for nine critical components to permit swift change-over in case of a failure without a protracted warm-up period.

—Automatic indication at the CDC if the telemetry link is lost.

—Automatic selection by the spacecraft of a good receiver and a good central command decoder. It carries two of each.

—Spacecraft retransmission of incoming commands so that signals can be compared bit-by-bit to verify correct reception of magnitude commands.

—Provision that some irreversible actions can be initiated only by two sequential commands.

—Visual display of command identifier numbers as they are encoded and before they are transmitted so that erroneous commands can be caught.

—Binary readout of command words as they are sent to detect errors inserted after the pre-transmission check.

—Printout of command identifier numbers after transmission.

—Insertion of a compound error detection code in every command word. The spacecraft will not execute a command in which an error is detected.

An element of reliability is flexibility in adapting to the various situations encountered during the mission. To obtain this the CDC offers its operators five means of entering commands into the system: emergency mode; manual mode; tape mode-manual; tape mode-automatic transit; and auxiliary mode.

Most commands will be entered from tape with manual or automatic transmit depending on the speed needed. Tape makes it possible to minimize errors by checking the sequence before launch. Operators have access to all data channels so they can check for proper execution.

The CDC is a modulating and demodulating system with three subsystems: command, telemetry and television. It consists of a three-position operator's console and eight racks of programing, recording, and testing equipment. A prototype is now being tested.

• **Storage concepts** — According to a study reported by W. Richard Davison and Jeffrey P. Carstens of United Aircraft Corp., developer of the cryogenic propellant RL-10 rocket, storability will probably not be the dominant factor in selecting propellants for stages which must be kept loaded in space or on the Moon for long periods.

Specific impulse and propellant density are expected to continue controlling stage weight, especially for relatively short storage times. This conclusion is based on the assumption that multilayer metal foil super-insulation with vacuum between the layers of foil will be available by the time the requirement appears. For storage times longer than two weeks or with inferior insulation, weight penalties associated with storage of cryogenic propellants begin to be appreciable.

Storage concepts evaluated by the authors included vented constant pressure systems, non-vented constant volume systems, and refrigerated systems. They were compared by the criterion of weight added to prevent or compensate for loss of propellant due to heat input.

Design problems raised by long-term storage in space include development of metal foil super-insulation capable of withstanding the acceleration and vibration of launch, and the engineering of structure which will not permit too much heat to leak past the insulation through its solid members.

Other notable technical announcements at the ARS meeting:

• Minneapolis-Honeywell claimed development of the first superconducting, three-axis accelerometer of inertial-guidance quality. Sensitivity 100 times better than that of existing accelerometers is expected. The inertial mass of the unit is a niobium sphere suspended in a magnetic field. The entire unit is kept at 5°K to sustain superconductivity. The surface of the niobium ball and wires generating the magnetic support fields are superconductive. Movement of the ball during accelerations causes fluctations in the supercurrent flowing in the field coils. These are interpreted to measure accelerations.

• United Technology Center of United Aircraft Corp. has demonstrated segmented solid-propellant rockets with a new type of segment joint which makes it possible to use fiber glass cases. Previously, fiber glass had been considered impractical for segmented motors because of the problem of getting strength and effective sealing at the joints. UTC will soon test a 156-in. segmented case of fiber glass.

• Safety measures incorporated in the lunar landing simulator being designed by Bell Aerosystems Co. for delivery to NASA in early 1964 include sufficient thrust in the turbojet engine to counterbalance five-sixths of Earth's gravity, and in the simulated lunar lift rockets so that either system will permit a safe landing if the other fails. The simulator will be able to take off, fly to an altitude of 8000 ft., travel a distance of three miles, simulate a lunar landing of two minutes duration, and return to the take-off site under the power of the General Electric turbojet and the hydrogen peroxide lift rockets. Attitude control system of the two-man vehicle is duplicated in case one should fail. The automatic jet throttle control is backed up by a manual override and the jet engine gimbal has a back-up and locking mechanism. Final safety measure is a zero-velocity, zero-altitude ejection seat for each crewman. ⁂

## Allen Heads AIA Board

Boeing President W. M. Allen has been elected chairman of the Aerospace Industries Assn. Board of Directors. Douglas Aircraft President D. W. Douglas, Jr., was elected vice chairman.

Executive committee of the board was increased from six to eight members. Besides Allen and Douglas, others elected to this committee were: North American Aviation Chairman J. L. Atwood, Bendix Corp. President M. P. Ferguson, Sperry Rand Corp. Executive VP C. G. Holschuh, Aerojet-General Corp. President D. A. Kimball, Grumman Aircraft Engineering Corp. President E. C. Towl, and—when named—the president of AIA.

Industry executives named to the board of governors for 1963 included: Kimball; Kerr; Bell Aerospace Corp. President Harvey Gaylord; Ferguson; Allen; Continental Motors Corp. President C. J. Reese; Curtiss-Wright Corp. Chairman and President T. R. Berner; Douglas; General Dynamics Corp. Vice Chairman E. D. Johnson; General Electric VP J. S. Parker; Towl; Ling-Temco-Vought Board Chairman Robert McCulloch; Lockheed Aircraft Corp. Board Chairman C. S. Gross.

Also named: Marquardt Corp. President R. E. Marquardt; Martin Co. President W. B. Bergen; McDonnell Aircraft Corp. President J. S. McDonnell; Atwood; PneumoDynamics Corp. President S. S. Mullin; RCA VP, Defense Electronics Products, A. L. Malcarney; Republic Aviation Corp. President M. I. Peale; Rohr Corp. Chairman F. H. Rohr; Ryan Aeronautical Corp. Chairman T. C. Ryan; Holschuh; Thompson Ramo Wooldridge Inc. Chairman J. D. Wright; United Aircraft Corp. Chairman H. M. Horner; and Westinghouse Electric Corp. VP C. H. Weaver.

When named, the AIA president will also serve on the board of governors.

## Mergers & Acquisitions

Raytheon Co. has acquired the assets and business of Autometric Corp. of New York City, a subsidiary of Paramount Pictures Corp. Transaction does not include Autometric's interest in Conductron Corp. of Ann Arbor, Mich., but does cover Autometric's Tinsley Laboratories, Inc., Berkeley, Calif. . . . *Corning Glass Works has acquired substantial interest in Signetics Corp., a Sunnyvale, Calif., microelectronics firm.* . . . Royal Industries, Inc., Pasadena, Calif., producer of precision equipment for missile/space applications, has bought Thomsen Supply, Inc., Gardena, Calif., for an undisclosed sum. . . . *Litton Industries will purchase Emertron, Inc., Silver Spring, Md., and merge it into Litton's Systems Group. Emerson Radio & Phonograph will receive Litton securities for its 86% interest in Emertron.* . . . G. T. Schjeldahl Co., Northfield, Minn, is negotiating to buy Electro-Craft Corp. of Bloomington, Minn. The purchasing firm produces high-altitude balloons and communications satellites.

## New Firms and Divisions

Mesa Scientific Corp., Inglewood, Calif., has formed a new subsidiary, the Systems Programming Corp., for computer systems programing and complete design and development services for computer software packages. . . . *Cal-Val Research and Development Corp. has organized a new Cryo-Therm Div. to market a rocket exhaust simulator and a cryogenic vapor former, for which patents are pending. Recently acquired Sierra-Schroeder Controls Div. will handle manufacture of these and other developments.* . . . Atlantic Semi-conductor, Inc., Asbury Park, N.J., has been set up to manufacture a varied line of semiconductor products. . . . *United Technology Corp., Sunnyvale, Calif., has been shifted from subsidiary to division status by its parent firm, United Aircraft Corp. Tax benefits are one reported reason for the shift. UTC is now known as United Technology Center.* . . . As part of a wholesale expansion of its computer capabilities, Research Analysis Corp. has set up a Computer Sciences Div. RAC is an independent, nonprofit operations research and systems analysis group specializing in military problems. . . . *Loral Electronics Corp., New York City, has merged its Countermeasures Div. with its Missile Technology Div. The new combined unit will be known as the Information and Control Systems Div., and will also be located in New York.* . . . Aerojet-General Corp. is entering the commercial, non-military market through a new unit, Aerojet Commercial Products Facility. This is the firm's first venture into microminiature electronics completely separate from its military projects.

## Industry Facilities

General Electric plans to build a 246-acre Aerospace Industrial Park at Daytona Beach, Fla. The new facility will have growth potential for 18 principal buildings eventually accommodating 3000 employees of GE's Command Systems Div. Construction will begin immediately on three office and lab buildings for the new *Apollo* Support Dept. These buildings, to be ready in April, will provide 165,000 sq. ft. of working space, while overall plans for the park promise over a million sq. ft. . . . *Gertsch Products, Inc., Los Angeles electronic instrument producer, has leased adjoining facilities to increase manufacturing and engineering space by one-third. This is the second substantial addition to the firm's facilities in the past 16 months, resulting in a total of 72,000 sq. ft. of working space.* . . . Hurletron, Inc., has completed a new manufacturing and production facility at Whittier, Calif. Hurletron's Whittier Div. is subcontractor on a variety of missile/space projects. . . . *A new manufacturing plant has been constructed at North Haven, Conn., by the newly formed Phelps Dodge Electronic Products Corp. The plant covers 51,500 sq. ft.*

# contracts and procurements

## AWARDS

### AIR FORCE

$15,000,000—**Boeing Co.,** Seattle, Wash., for *Minuteman* missiles and related equipment (supplemental contract).

$7,094,039—**General Dynamics Corp.,** New York City, for work on *Atlas E* improvement program at San Diego (supplemental contract).

$6,107,500—**International Telephone & Telegraph Corp.,** New York City, for work on a space communications system at Paramus, N.J., (supplemental contract).

$6,000,000—**International Telephone and Telegraph Corp.,** New York City, for supply and installation of a communications system for the *Minuteman* missile site at Whiteman Air Force Base, Mo. Work will be done by ITT's Kellogg Communications Systems Div., Chicago.

$5,000,000—**Radio Corp. of America,** New York City, for work on the Ballistic Missile Early Warning System. Work to be done at Moorestown, N.J. (supplemental contract).

$1,349,000—**Hughes Aircraft Co.,** Culver City, Calif., for long lead time items for *Falcon* missiles (supplemental contract). Work to be done at Tucson, Ariz.

$1,032,480—**Fairchild Camera & Instrument Corp.,** Syosset, N.Y. for development of photographic image interpretation equipment.

$1,000,000—**Avco Corp.,** New York City, for research and development work on re-entry vehicles at Wilmington, Mass.

$1,000,000—**Bendix Corp.'s Pacific Div.,** North Hollywood, Calif., for a sonar system that will help missile-tracking ships pinpoint the location of nose cones or instrument packages when they land in the sea.

$598,000—**United ElectroDynamics, Inc.'s United Aerospace Div.,** Pasadena, Calif., for the production of 56 transistorized airborne telemetry systems which will be flown on operational flights of the *Atlas, Thor* and *Titan* missiles from Vandenberg Air Force Base.

### ARMY

$4,834,093—**Hercules Powder Co.,** Wilmington, Del., for rocket motors and various types of propellants.

$3,927,000—**Diverco Constructors,** Los Angeles, for work on solid motor development at Complex 1-36 and two test stands and support facilities for solid motor components of the *Titan III SLV-5.*

$3,874,000—**Raytheon Co.,** Lexington, Mass. for *Hawk* missile system components. Work to be done at Andover, Mass.

$1,882,312—**Belock Instrument Corp.,** College Point, N. Y., for engineering services on the *Hawk* missile system.

### NAVY

$13,500,000—**Westinghouse Electric Corp.,** Baltimore, Md., for design and development of missile guidance equipment.

$2,700,000—**Bendix Corp.,** Mishawaka, Ind., for continued research and development of the *Typhon* missile system (supplemental contract).

**Crane Co.'s Hydro-Aire Div.,** Chicago, Ill., for dummy *Tartar* missiles with a solid propellant motor to be used in testing *Tartar Mk-15* launchers (undisclosed amount).

### NASA

$12,000,000—**McDonnell Aircraft,** St. Louis, for additional funding for *Gemini.*

$2,560,000—**Ling-Temco Vought,** Dallas, Tex., for development of the velocity package for *Project Fire.*

$273,570—**Crysler Corp.,** New Orleans, La., for purchase of three test consoles.

**Vitro-Smith Corp.,** New York City, for design, furnishing, installing and testing a new space environmental chamber at the Langley Research Center (undisclosed amount).

**Vickers. Inc.,** New York City, for design and development of an integrated pulse modulated 60-lb. thrust chamber for the Manned Spacecraft Center, Houston (undisclosed amount).

### INDUSTRY

$10,165,000—**Genneral Motors' Allison Div.,** Indianapolis, Ind., from **Aerojet-General Corp.,** for production of titanium second-stage rocket motor cases for the *Minuteman* missile.

$3,000,000—**Rohr Corp.,** Chula Vista, Calif., from **Western Electric,** for microwave relay antennas at Bell System installations in the U.S.

$2,700,000—**United Control Corp.,** Redmond, Wash., from the **Boeing Co.,** for follow-on production of special ground based environmental control systems equipment used on the *Minuteman* missile.

$1,500,000—**Perkin-Elmer Corp.,** Norwalk, Conn., from **Sylvania Electric Products, Inc.,** for developing and building optical systems for the Orbiting Astronomical Observatory.

$1,000,000—**Moog Sevrocontrols, Inc.** East Aurora, N.Y., from **General Dynamics/Pomona,** for electrohydraulic servovalves for use in *Terrier* and *Tartar* guided missiles.

$500,000—**Electradata Corp.'s Data Products Div.,** Los Angeles, from **International Telephone and Telegraph's Federal Labs,** for several advanced models of Electradata's Datacom systems.

**Western Scientific Instrument Co., Inc.,** from the **Jet Propulsion Laboratory,** for providing calibration, maintenance and repair service to electronic testing and measuring equipment (undisclosed amount).

**Swedlow Inc., Los Angeles,** from **Lockheed Missile & Space Co.,** for research and development work on Teflon-coated stainless steel positive-expulsion bladders for an advanced thrust vector control system (undisclosed amount).

**Packard Instrument, Co.,** Albuquerque, N.M., from the **Jet Propulsion Laboratory,** for development and assembly of two prototype gamma ray detectors (undisclosed amount).

## REQUESTS FOR BIDS

### GENERAL PROCUREMENTS

Headquarters, Space Systems Div.
Air Force Unit Post Office
Los Angeles 45, Calif.
Attn: SSTK

Sources sought to operate a cleaning and hydrostatic testing facility for missile booster and aerospace components and parts at Vandenberg AFB, Calif. Successful contractor will manage and provide personnel for operation of present facility, which cleans parts generated from parent items using liquid oxygen/hydrocarbon, helium and cryogenic liquids. The majority of these parts requires no special handling equipment. Past experiences show the normal workload to be 32,000 items per month. The Government will provide the facility, special tooling, protective clothing, parts and consumable supplies. Contractor personnel will provide their own hand tools common to the trade for use in disassembly and reassembly of components. We plan to contract for a 12-month period by using a firm fixed price contract for labor with provisions for procurement of equipment, parts and supplies on a cost reimbursable basis. The facility operates on two 8-hour shifts with personnel consisting of 22 people, which includes a foreman for both the day and night shifts and one secretary. Firms desiring to receive an RFP must demonstrate past experience and capability in chemical cleaning, disassembly, and assembly of missile and/or propellant-transfer system components. Specifically, your response should state in detail (1) company experience in the performance of this type of activity (2) academic training and experience of key managerial personnel with short resumes, (3) operational capability to perform without undue delay assuming contract may be let in February 1963. Telephone requests will not be accepted. Responses should be mailed to Hq., SSD, Air Force Unit Post Office, Los Angeles 45, Calif. Attn. Mr. Roy A. Watkins (SSKB). The following firms are being considered for solicitation and need not respond: Compudyne Corp., Planetech Corp., and Dow Chemical Co.

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Bureau of Naval Weapons
Washington 25, D.C.

Production sources sought. The Bureau of Naval Weopons in conjunction with the U.S. Naval Ordnance Plant, Louisville, Ky., will procure a quantity of liquid propellant rocket engines for air launched missiles. This unit is a tankage-type rocket engine manufactured principally fom machined aluminum fogings and weided into one integral unit. Certain inside surfaces require thermal insulation. The approximate weight is 100 lbs. before loading. Aspects of the procurement carry DOD security classification of "Confidential." Therefore, prospective bidders must already possess a current facilities security clearance of "Confidential" as set forth in Industrial Security Manual for Safeguarding Classified Information. Prospective bidders will be requested to bid on a limited quantity and tooling cost for the purpose of establishing a satisfactory production line. The RFP will state production rates. No government furnished tools or capital equipment in addition to those already in the bidder's possession will be available. Options for additional quantities will be included in the RFP. Prospective bidders will be requested to quote on loaded and unloaded engines. Drawings and RFPs will be forwarded upon written request and certification of proper security clearance and will be available by 12-7-62 to bidders who make requests prior to that date to Bureau of Naval Weapons, Code NPR, Mr. Peterson, Room 0330, Main Navy Building, Washington 25, D. C. Phone: OXford 6-2743. Documentation, including drawings and specs, may be ambiguous to prospective bidders; therefore, the Naval Ordnance Plant, Louisville, in conjunction with the Bureau of Naval Weapons, Washington, D.C., will conduct a bidders symposium for the purpose of conveying complete detail information relative to this engine to recipients of RFPs. This symposium will be held at 9:00 AM, 12-19-62, at the Kentucky Fair and Exposition Center, Freedom Hall, Room B, Louisville, Ky. All prospective bidders are urged to attend this symposium. To gain admission to the symposium, companies must forward to the U.S. Naval Ordnance Plant, Louisville, Ky. (Attn: Programs Management Office), prior to 12-7-62, the list of names of their representatives who will attend this symposium, along with sufficient security clearances showing that these individuals are cleared to observe confidential documentation and equipment. Each firm will be limited to 3 attendees. C/N 2860-63. BuWeps Synopsis No. 167-63.

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Dept. of the Army Engineer District, Omaha
Corps of Engineers
6012 U.S. Post Office and Courthouse
215 N. 17th St.
Omaha 2, Nebraska
Attn: Construction Div.

Construction of SAC antenna supports, Lincoln *Atlas F* sites, Lincoln, Nebr. Work will include the following: Construction of a total of 13 antenna silos at 12 sites. Silos to consist of reinforced concrete slab foundation, (a) 9 ft. diameter ½ in. thick steel shell extending 28 ft. below grade and a 3 in. thick steel plate roof and door. Installation of government-furnished hydraulic door operating mechanisms complete with electric control panel and shock insulation mountings. Electrical work including water level alarm, door heater cable and connections to government furnished equipment, (b) construction of one antenna slab at each of 12 sites. Slabs to be 11 ft. in diameter by three feet thick reinforced concrete (c) underground electrical circuits to control center, (d) 2300 SY of 12 in. thick slab aggregate surfaced access roads, (e) site grading and seeding. Approximate value of proposed construction—$500,000. A payment of $5.00 per set is requested in the form of a certified check or U.S. money order made payable to the Treasurer of the U.S. The payment will not be refunded and the drawings need not be returned. Job—IFB ENG-25-066-63-60. Bid opening 12-21-62. Drawings, specs and bid forms furnished by the Corps of Engineers, Omaha, Nebr.

# names in the news

**William S. Allen:** Appointed senior scientist in the Electrochemical Dept. of the Research and Development Laboratory of Erie Resistor Corp., Erie, Pa.

**John E. Gray:** Appointed chief of support systems for Minneapolis-Honeywell Regulator Co.'s Military and Space Sciences Dept., Washington, D.C. **Richard G. Weber** appointed chief of command and technology.

**George Tuck:** Appointed group manager in charge of electromechanical production of Kinetics Corp., Solana Beach, Calif.

**K. M. Fullerton:** Named manager of General Electric Co.'s Defense Programs Operation, San Bernardino, Calif.

**John F. S. Abbott:** Appointed to the new post of rocket rubber sales manager for the Naugatuck Chemical Div. of the U.S. Rubber Co., Naugatuck, Conn.

**Edmundo Gonzalez:** Appointed manager, Special Products Operation, Lansdale Div., Philco Corp., Lansdale, Pa.

**Joseph R. Bruman:** Joined the Guidance and Control Systems Div. of Litton Systems, Inc., Beverly Hills, Calif., as a staff planner.

**Theodore Kanell:** Appointed sales manager for New Hampshire Ball Bearings, Inc., Peterborough, N.H.

**Harry A. Jackson:** Appointed resident plant manager for Spectrol Electronics of Canada, Ltd., subsidiary of Spectrol Electronics Corp., San Gabriel, Calif.

**John Walovich:** Promoted to director of engineering for Stancor Electronics, Inc., Chicago.

**Michael J. Ganz:** Elected assistant treasurer of International Telephone and Telegraph Corp., New York City.

**Col. Jack L. Bentley (USAF ret.):** Appointed manager-business acquisition planning for General Electric's Light Military Electronics Dept., Utica, N.Y.

**Robert Burns:** Appointed regional sales manager in the southeast for Motorola Semiconductor Products, Inc., Phoenix, Ariz.

**William R. Browne:** Elected to the board of directors and appointed vice president of Meletron Corp., Los Angeles.

**John E. Woodward:** Named corporate director of material for Texas Instruments, Inc., Dallas.

**Stanley J. Hardman:** Elected president of Hardman Tool and Engineering Co., Santa Monica, Calif.

**William E. Dundon:** Appointed industrial sales engineer of OPW Div. of the Dover Corp., Cincinnati.

**Dr. Richard D. DeLauer**: Associate director, ballistic missile program management and director of Space Technology Laboratories, Inc.'s *Titan* weapon program office, Redondo Beach, Calif., elected a vice president of STL. **Dr. Robert Bromberg,** director of the mechanics division; **Edward M. Foley,** treasurer and director of corporate planning and control; **Dr. George E. Solomon,** director, systems research and analysis division, also elected vice presidents.

**J. J. McDonald:** Named general manager of Packard Bell Computer Division of Packard Bell Electronics, Los Angeles.

**Robert B. Hutton:** Elected vice president and general manager of Guardian Electric Co.'s Culver City, Calif., operations.

**Carl H. McBain:** Elected a vice president of the Perkin-Elmer Corp., Norwalk, Conn., and also director of marketing for the Instrument Div.

**Dr. Richard K. Orthuber:** Promoted to director of the Electro-Optical Laboratory at ITT Federal Laboratories, Nutley, N.J.

**W. M. Hawkins, Jr.:** Promoted to sales manager of the Electronic Engineering Co., Santa Ana, Calif.

**Theodore H. Crane:** Promoted to director of research and product development, High Vacuum Equipment Corp., Hingham, Mass.

**Frank L. Salizzoni and Howard A. Markham**: Appointed operations analysts at the Research Analysis Corp., Bethesda, Md.

**Douglas C. Strain:** Chairman of the board and president, Electro Scientific Industries, Portland, Ore., elected chairman of the Scientific Apparatus Makers Association's Electronic and Electrical Instrument Group, Chicago.

**Arthur T. Ruppe:** Appointed general manager of the Bendix Foundries division of the Bendix Corp., Teterboro, N.J.

**Edward E. Baumna**: Appointed vice president and elected to the board of directors of Signalite, Inc., Neptune, N.J.

**Leonard F. Cramer:** Appointed executive vice president of Airtronics International Corp., Fort Lauderdale, Fla.

**Ralph E. Moyer:** Appointed manager of missile engineering for Beech Aircraft Corp., Wichita, Kans.

**Page G. Whitmore:** Appointed marketing research manager for the electrical products groups of Minnesota Mining and Manufacturing Co., St. Paul, Minn.

**Joseph L. Flood:** Appointed manager in charge of advanced reliability programs of Motorola's Semiconductor Products Div., Phoenix, Ariz.





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GENERAL ELECTRIC




Circle No. 7 on Subscriber Service Card

# Gage Eliminates Surface Heat Loss

TEMPERATURE MEASUREMENTS of surfaces with thermal capacities so low that any heat removal during the process constitutes an error are now possible with a zero heat flow, null-type gage.

Though there are many kinds of instruments designed to indicate surface temperature, there are often cases where the mere contact of the measuring device causes heat loss and a questionable reading.

In these instances, it is necessary to use a measuring technique that avoids contact or is designed to remove the possibility of heat flow in either direction. Non-contact means such as radiation devices rely for accuracy on the degree of certainty with which the surface emissivity can be determined. This is extremely difficult with some translucent materials, and materials in which surface emissivity may vary.

In addition, many objects transmit sufficient background radiation to seriously affect instrument accuracy.

The zero-flow, null-type gage invented by Chemstrand Co. and developed jointly by Chemstrand and Hastings-Raydist, Inc., is a contact measuring instrument that avoids the heat-flow problem.

• **Operating Principle** — In effect, the sensing element of the Matchtemp Pyrometer® is a null-type thermocouple heated to the approximate temperature of the surface to be measured. It is heated by an internal junction welded to one or more of the legs.

When the probe is applied to a stationary or moving body, the instrument instantly indicates the temperature differential between the material surface and the probe. The result can be indicated on a direct-reading meter.

Should the temperature be below that of the thermocouple, the needle will deflect below the thermocouple temperature—if above, the opposite will be true. When no change in temperature appears on contact, both probe and material are the same temperature.

To adjust the instrument to surface temperature, it is necessary for the user to make two or three contacts with the object, adjusting the thermocouple each time to compensate for the indicated difference. This operation is handled in a few seconds, say Hastings-Raydist experts.

The major advantage of the gage is elimination of heat flow in either direction. In addition, the probe itself is unaffected by heat radiation either from the material or the surrounding atmosphere. The temperature established on the dial control is exactly that maintained by the thermocouple.

It is not necessary to make an immersion stem correction or to wait while the thermocouple comes to temperature. For all practical purposes, a change in the dial results in an instant change in instrument temperature.

When the probe is placed in contact with the medium, the temperature differential is instantly indicated. Accuracies on readout of nylon lines running in excess of 600 fpm has ranged between 0.25° and 0.5° C.

Because of its light weight and sen-



## New Product of the Week: Oscillator Synchronizer

Stabilization of VHF and microwave signals to one part in $10^8$ short term is provided by an instrument produced by Dymec Div., Hewlett-Packard Co. The DY-2650A oscillator synchronizer provides extremely stable signals, as required in such areas as Doppler systems, microwave frequency standards labs, and parametric amplifier pump applications. The unit phase locks a reflex klystron oscillator to an internal crystal reference to achieve stability of one part in $10^8$ per second, one part in $10^6$ per week. Temperature stability is one part in $10^6$ through the range 0-50°C.

The DY-2650A will synchronize most reflex klystrons, one to 12.4 gc, with complete elimination of klystron drift.

Circle No. 225 on Subscriber Service Card

## Programable Digital System

Control Logic, Inc., offers a programable digital system for testing, designing, simulation and training in digital systems. The unit is a complete 2-bay console containing a selection of control logic patchcord logic panels. Using the panels, the systems design engineer may proceed directly from logic diagram to actual operating system simply by patchcording the proper circuitry.

Large logic symbols, between color-coded banana jack terminations for circuit interconnection, provide immediate visual reference to the logic function. Each panel is a complete unit mounting the modular products of series DC1 or DC2 circuits wired to the panel jacks. Connection of three power-supply levels make these units ready for system simulation, logic design, on-line small systems, test equipment or training in digital systems techniques.

Features include: DC to 2.0 mc static logic circuits with choice of diode or transistor gating; 28 standard panels from which to select specific requirements; each panel a complete sub-func-



*THE MAICHTEMP Pyrometer® gage provides an accurate instant temperature-measuring system where thermal capacity of the object to be tested is low. An example is in measuring fiber surface temperatures, illustrated here.*

sitivity, the probe will not damage the measured material. Using a fork probe, temperature profiles have been obtained on three-denier nylon filament without breaking the line or damaging the filament surface.

But the kind of thermocouple wire used limits the temperature-measuring capability of the instrument. The fact that it is a heated instrument restricts its use to above-ambient temperature applications.

The standard instruments available are suitable up to 456°F. Additional range can be provided by changing the thermocouple material or by using an external potentiometer: In most applications, this has not proven necessary.

• **Probe Configurations**—The probe type is highly dependent on the application. For instance, in measuring moving filaments, a fork-type is especially suitable. The sensing element is in the center of a cross, forming a rigid structure. Half the cross is heated directly by controlled current, and the temperature at the junction is indicated by the output device.

A second unit, in the form of a narrow finger, is used to measure the surface temperature of processing equipment or operating devices. The sensing element is again a crossed thermocouple with two legs heated and the other two in the measuring circuit.

The final probe configuration is a button type used for measuring relatively flat surfaces. A protective flange with rounded edges surrounds the probe so that the sensing element can touch the object without snagging or tearing the surface.

Temperature readout is through the visual meter or by means of either recorders or sound indicators. Recorders are adaptable to continuous measurement. For example, a cyclical variation in a-c power may be applied to the instrument, causing the temperatures to fluctuate above and below the temperature of the surface to be measured. During this control cycle, the probe is touched to the object surface and the resulting temperature difference is indicated on the recorder.

This method eliminates operator adjustment, making the equipment semi-automatic. In some cases, the recorder is equipped with an event marker to simplify temperature reading. ❖

Circle No. 269 on Subscriber Service Card

tional unit; and input-output circuit load units marked on panel at each jack to simplify inter-connection of circuits.

Circle No. 226 on Subscriber Service Card

## Airborne Transducer

A teleflight bonded strain gage pressure transducer/amplifier Model 185/290-1 has been developed by Taber Instrument Corp. The unit is specially designed for space vehicle and rocket applications where reliability, weight and size are most important. It delivers an amplified, 5 volt d-c signal in proportion to the applied pressure.

Having an output impedance of approximately 15 ohms the Model 185/290-1 is ideally suited to operate telemetering and servo systems, meters, recorders, and control equipment. Vibration and acceleration sensitivity are reported to be less than 0.005% full scale per g for ranges above 0-250 psi. Providing fast response to transient pressures, the instrument will withstand pressure overloads up to three times full scale.

Circle No. 227 on Subscriber Service Card

## Circuit Module Connector

A connector for printed and welded circuit modules, featuring a 1/10 in. grid-connection pattern, is available from Barnes Development Co.

Circuits with leads as short as 3/32 in. can be contacted and a variety of wire diameters is accepted. Insertion force is low, and contacts are gold-plated beryllium copper. Typical life is in excess of 100,000 insertions.

Insulation material is phenolic or Teflon, and these connectors are suitable for use in all types of environmental and room ambient conditions up to 200°C.

Circle No. 228 on Subscriber Service Card

## VSWR Detector

Telonic Engineering Corp. has available a VSWR measuring device capable of providing outputs for null indication or scope display of reflection coefficients.

The Rho-tector employs a bridge circuit to provide a d-c signal proportional to the magnitude of the reflected coefficient of unknown as compared to the standard. VSWR measurements may be made by null-balancing with a galvanometer or a VSWR meter, or can be displayed on an oscilloscope when used in conjunction with a sweep generator. It is adaptable to the testing of filters, amplifiers, couplers, and other coaxial components. It can be used in both the laboratory and in production where the oscilloscope display is extremely useful for determining VSWR values rapidly and accurately.

Circle No. 229 on Subscriber Service Card

## Logic Transistor

Texas Instruments Semiconductor-Components Div. has developed a transistor capable of delivering greatly improved performance in existing high-voltage switching circuitry for logic applications.

Specifications on the 2N2635 include: $BV_{CEO}$ of 12 volts; $BV_{CBO}$ of 30 volts; $t_T$ (total switching time) as low as 240 nanoseconds in a typical circuit; plus the extremely rugged mesa construction capable of withstanding forces in excess of 35,000 g's in the critical $Y_1$ plane.

Circle No. 230 on Subscriber Service Card

## Backward Wave Oscillator

The Microwave Device Div., Sylvania Electric Products, Inc., has developed an S-band backward wave oscillator that features an integral permanent focusing magnet, ambient cooling and a new light weight package.

The SYB-4400 is designed to operate over the entire S-band, 2-4 Gc, with a power output of 100 mw minimum. It is equipped with a control grid to facilitate low-voltage pulsed or amplitude modulation. The grid may also be used with a simple power leveling device to insure a flat power output ±1.5 db across the entire band.

The frequency output may be electrically swept from 2 Gc to 4 Gc by sweeping the delay line voltage from 150-1450 volts.

The improved electrical design of the SYB-4400 has very closely controlled frequency versus tuning voltage. The tuning response of individual tubes can be held consistently within ±4 percent from a given frequency versus tuning voltage curve. The power output across the band varies by no more than 10 db.

Circle No. 231 on Subscriber Service Card

## Rotary Stepping Switch

Hurletron Inc. is marketing a rotary stepping switch designated the 6000 Series. The rotary line is characterized by small size and light weight, while offering current carrying capabilities from dry circuit to 10 amp at 28v a-c or 115v a-c. In addition, units are capable of withstanding shock of 50 g's, vibration at 10 g's through 2000 cps, environmental temperature range of from −70°C to 125°C and conform to MIL-R-6016-C.

Circle No. 232 on Subscriber Service Card

## Silicon Module

Two silicon modules are available from Scientific Data Systems, Inc., for driving either an incandescent display or a Nixie display. Both operate at 0-100°C and permit direct decoding of any of the following codes: (8, 4, 2, 1), (2, 4, 2, 1), (5, 4, 2, 1), (4, 2, 2, 1), Excess 3 or Gray. Output is 10 lines while input uses standard SDS silicon-module voltage levels of zero and 8 volts.

Circle No. 233 on Subscriber Service Card

## Transverse Probe

A transverse test probe for determining direction and density of fields in alternating magnetic fields in laboratory, military and industrial applications is available from Magnetic Shield Div., Perfection Mica Co. The probe's



construction facilitates magnetic field attenuation measurements in shielding structures where the field direction is normal to the probe's axis. This is accomplished by positioning the air core pickup coil within the Faraday type of electrostatic shield enclosure with its axis normal to the electrostatic shield's axis. The field measurement plane is indicated by a reference line along the cylinder length. The RMS gauss reading is easily obtained by noting the AC VTVM reading and using the simple formula furnished with the calibrated probe.

Circle No. 234 on Subscriber Service Card

## Transmitting Tubes

A compactron and two nine-pin miniature transmitting tubes specifically designed for reliable and economical high-band mobile communications are available from General Electric Receiving Tube Department.

The type 8156 is a medium-power transmitting tube with 15 watts plate dissipation at 175 mc. A new multiplier-driver tube, type 8106, is rated at six watts plate dissipation. The 8106 can double and drive the 7984, can drive two 7984's in push-pull, or can double and drive a pair of 8156's. For frequency tripling and FM modulator, the triode-pentode type 8102 now is available. All employ 13.5 volt heaters.

Circle No. 235 on Subscriber Service Card

## Pulse Generator

Developed by Digital Systems, Inc., the Model DS-25 25-megacycle Pulse Generator is designed to cover a multitude of applications requiring solid-state reliability at very high repetition rates.

Repetition rate is 500 kc-25 mc continuously variable over the entire range. Duty cycle, adjustable to 50% over the entire range, is automatically selected. Rise-fall time is 4 nanoseconds; output ±10 volts into 93 ohms, output attenuation range 0 — 40 db in 5 steps. Power requirements: 117 volts ±10%, 50/60 cps, 30 w.

Circle No. 236 on Subscriber Service Card

## Accurate Synthesizer

Accepting a standard frequency input, the Model 301 Synthesizer developed by Montronics, Inc., can provide any customer-specified frequency from one to 32 mc in increments as small as 100 cps. With accessory multipliers, this frequency range can be extended to 480 mc. Long-term stability and accuracy are that of the reference standard.

Adaptable and versatile, this synthesizer features excellent short-term stability, harmonic content of 40 db below fundamental spurious content of 70 to 90 db below desired frequency, and standard input of 100 kc, 250 mv into 50 ohms (with 1 mc input also available).

Typical applications include use in standards or scientific laboratories, and with navigation, radar and communications systems.

Circle No. 237 on Subscriber Service Card

## Semiconductor Tester

A rapid-speed semiconductor test station using a unique method of automatic programming is available from Optimized Devices, Inc.

Designed to subject transistors or diodes to a full-range of tests, the Model 1500 automatic transistor test station is pre-programed via the unit's punched tape program module to make any sequential semi-conductor measurements on a go-no-go and data logging basis. Provisions for metering, continuous scanning, digital readout, printout, card punch, yield counts and bin selection are also available.

Circle No. 238 on Subscriber Service Card

## PCM Decoder

A PCM decoder with 0.1% accuracy is being marketed by Correlated Data Systems Corp.

Model PCMD-1000 provides ground station telemetry engineers with a convenient way to develop parallel-binary and analog information from a serial digital wave train using the NRZ format.

All circuitry is 100% solid state with 0.1% accuracy over the temperature range of 0°C to 50°C. Conversion capability is at five, six, seven, eight, nine, or 10 bit levels. Various models in this product family can be supplied which provide up to six such converters in a single panel-mounted assembly.

Simplified front panel pushbutton controls manually provide data, bit sync and word sync. Data input characteristics include 10 to 200,000 bits per second, serial NRZ-C format with "Zero" —0 to 0.2 volts and "One"—5—10 volts.

Circle No. 239 on Subscriber Service Card

## Waveguide Adjustable Short

Waveline, Inc. has developed a complete series of adjustable waveguide shorts in eight standard waveguide sizes to cover the frequency range of 2.60 to 40.0 Gc. Most of the standard models use a non-contacting folded half-wave trap-type short circuit, except the lower frequency models, which are equipped with a spring-finger short circuit.

These adjustable precision instruments are used for terminating a waveguide transmission line at various points of the short circuit. When in combination with a waveguide tee section, they form a stub transformer that can be used as a tuner in a transmission line. They may also be used as a short-circuit reference plane in connection with impedance or admittance measurements.

Circle No. 240 on Subscriber Service Card

## Relays

Integrated Electronics is marketing a complete range of reed relays. Contacts sealed in a glass envelope filled with inert gas will handle up to 15 w at 250 v. Features are long life, switching speed, compactness, accuracy and ease of packaging. Coil voltages up to 110 vdc, standard and miniature packages are available. Typical of circuit characteristics in reed packages are latching, non-latching stepping, progression switching, logic modules, proximity switching and variable sensitivity.

Circle No. 241 on Subscriber Service Card

## Crystal Oscillator

A voltage-controlled crystal oscillator, Model 90814, which features extremely low phase jitter over an output frequency range of 44 to 54 mc with a frequency stability of three parts in $10^7$ short term, and 3 parts in $10^6$ long terms (10 min.) has been developed by Resdel Engineering Corp. Maximum control voltage range is ±3v with voltage-control sensitivity nominal 3 kc/v at output frequency.



The unit is designed for use where frequency deviation is required from a reference voltage. Typical applications are phase-locked circuits as used in GSE receivers, transmitters, signal generators and as a signal source for frequency multipliers. The units can be used for any type of servo-loop circuit in which locking frequency to a specific signal is required. It has the advantage of crystal stability combined with the flexibility of variable and remote frequency control. The unit is completely solid state with all components derated for maximum reliability and long life.

Circle No. 242 on Subscriber Service Card

## Current Regulator

A low-level current-limiting device capable of ±1 micromho regulation is available from Circuit Dyne Corp., a subsidiary of Telonic Industries, Inc. One of a series of CircuitDyne "Currector" constant current diodes, the model CP-8 is a two-terminal components that may be specified with any current level from 2.1 to 1 ma in 5% increments. Measuring 8-in. dia. x 1.05-in. long, the unit is encapsulated in epoxy and is available with single-ended or axial leads.

The CP-8 is a silicon type, capable of handling up to 40 volts and operating in a temperature range of −55°C to 100°C. Overall current regulation is ±0.1%. Its characteristics make it especially useful in circuits such as timing, sweep generation, and special instrumentation systems when working with low current values.

Circle No. 243 on Subscriber Service Card

## Velocity Plotter

A velocity plotter—designed to give a highly accurate analog profile of sled velocities with respect to time and position—is available from Resdel Engineering Corp. The Model 91058 plots information in real time with an accuracy of ±1%. It can measure velocities between 15 and 3,000 fps. The information is converted and presented to a standard XY-type recorder.

Circle No. 244 on Subscriber Service Card

## Butler Arrays

A wide variety of standard and custom-designed "Butler Arrays" has been developed by Advanced Development Laboratories, Inc. Each ADL Butler Beam Forming Matrix consists of a specific configuration of quadrature hybrids and fixed-phase shifters. When connected to an N-element antenna array, the matrix provides N simultaneous, overlapping isolated beams, each pointing in a different direction and using the full projected antenna aperture.

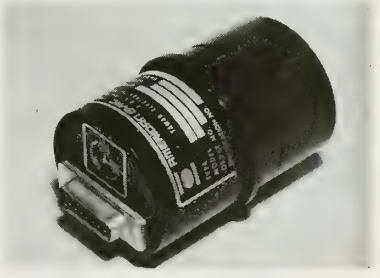
ADL Butler Matrices are offered in both narrowband and broadband models at any operating center frequency between 0.5 and 8.0 GC. Narrowband bandwidth is ±5%, broadband bandwidth is one octave. Adjacent beam isolation is 35 db.

Circle No. 245 on Subscriber Service Card

## Stored Energy Gyro

American Gyro, a division of Tamar Electronics Industries, Inc. is marketing their stored energy, two-axis, free gyro. The unit is designed for short-range missiles and similar ballistic projectiles. This kind of application requires immediate operation on launch and a control output in the roll and/or pitch attitude. However, the gyroscopic principle is also applicable to Rolleron controls and other devices that require a spontaneous acceleration of a rotating member.

Operational conditions are reached within 70 to 100 milliseconds after initiation signal. By replacing the entire power pack or recharging the spent power pack, the gyroscope can be made operational within a matter of minutes. The gyroscope, with the attached charged power pack, remains in a caged position until the power pack charge is



ignited and has accelerated the gyro spin rotor to its maximum speed, after which the gimbals are instantly released. Latest tests resulted in spin-motor accelerations with angular momentums in excess of two million (gm $cm^2$/sec.) within 100 milliseconds.

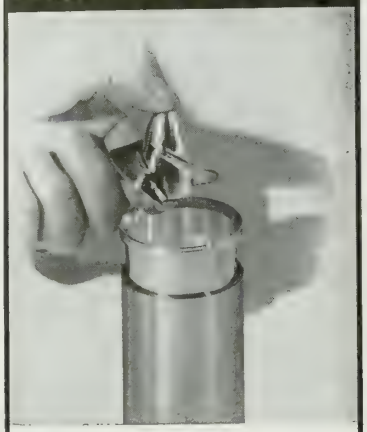
Circle No. 246 on Subscriber Service Card

## Differential Transformer

A differential transformer for high nuclear flux environment is available from Automatic Timing and Controls. It is specially designed to operate into double bridge rectifiers with a center balance meter and to provide temperature stabilization with a special excitation system with inductive ballast.

The coil operates as a flow meter with water pipe running through it and an armature in the pipe. The pipe is Type 347 stainless with a 0.400-in. wall thickness. The armature, of MU metal, is 1.5 in. long with an OD of 1.270 in. and an ID of 1.130 in.

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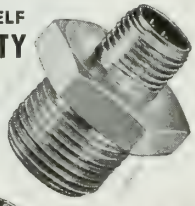
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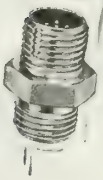
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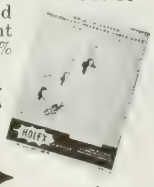




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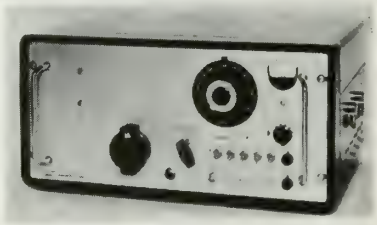
The unit can operate in temperatures up to 1000°F. Temperature is stabilized at 550°F—300°F within 5%. Neutron flux level is 5 x $10^4$ neutrons/$cm^2$/sec. Gamma ray flux level for cumulative doses is $10^8$ r and $10^8$ rem. It has an estimated stable lifetime of 25 years.

Circle No. 247 on Subscriber Service Card

## Sweep Generator

A sweep generator, the model PD-8, capable of delivering up to 4 watts of swept or modulated-swept RF power is available from Telonic Industires, Inc.

The instrument, covering the frequency range of 330 to 1010 mc, is



also capable of operating in CW and modulated CW as well as the two RF modes. Its output capabilities make it extremely useful for applications such as test and evaluation of varactors, klystrons, filters, or wherever high RF power levels are necessary. In RF operation, the sweep generator employs a special UHF triode to furnish up to 4 watts. In both CW modes, the instrument provides up to 2 watts with a 100% duty cycle. These outputs are available *after* 3 db of fixed attenuation used to maintain constant output level regardless of changes in loading.

The outputs may be accurately set at any value up to their maximums via a precise turret attenuator, graduated from 0 to 59 db in 1 db increments. This attenuator is in series with the 3-db pad, and if still lower outputs are needed, additional attenuators may be provided as accessory equipment.

Circle No. 248 on Subscriber Service Card

## Pressure Transducer

A high-performance digital output pressure transducer is available from Instruments, Inc.

The Model P606 converts pressure into a seven-bit unambiguous binary code output, which divides the pressure into 128 discrete parts. The instrument's output can be read visually or it can be fed directly into a magnetic tape system, typewriter system, etc.

This transducer measures pressures from 0 to 1 psi through 0 to 1000 psi FS; absolute, gage, and differential. Its size is approximately 1¾-in. dia., 3⅜-in. long. Combined non-linearity and hysteresis is less than ±1%FS. Input is 1 to 10 volts; output is a seven-bit binary code, 1 to 10 volts. The instrument operates over a temperature range of −65°F to 250°F, and thermal zero and sensitivity shift is less than 0.01%FS/°F.

Circle No. 249 on Subscriber Service Card

## Variable Attenuator Pads

Waveline Inc., Caldwell, N.J. offers a series of variable attenuator pads that provide inexpensive, well shielded, efficient, low level attenuation over the frequency range of 7.05 to 18.0 Gc. These minimum size units find application in isolating microwave devices, adjusting power levels in microwave networks, and reducing reflections in waveguide circuits.

Three standard models provide shielded variable attenuation from 0.5 to 20.0 db over the frequency range of 7.05 to 18.0 Gc. Maximum VSWR for each unit is 1.20 at a power level not in excess of one watt.

Circle No. 250 on Subscriber Service Card

## DPST Solid State Switch

The Alpha-Tronics Corp. is marketing Type SW-104 DPST solid-state switch that features differential offset of ±50 microvolts over −20°C to ±85°C with no adjustments required. No external drive transformer or floating gate input is required to excite the switch from continuously "on" to 10kc. The SW-104 is ideally suited for handling differential signals in the low millivolt range and due to the low back current generated signals in the low millivolt range and due to the low back current generated, variations in source impedance of 0 to 1K have no adverse effect on the dc offset. Welded construction is employed and the 0.29-cu.-in. switch module is fully encapsulated in low specific gravity epoxy resin resulting in a weight of only 7.5 grams.

Open switch resistance is greater than 1500 megohms at 85°C with a ±15 volt differential signal applied. Closed "contact resistance" is less than 80 ohms per pole. The SW-104 requires less than 70 milliwatts of power at 6 volts only when the switch is "on" and the signal to ground resistance is greater than 10K megohms.

Circle No. 251 on Subscriber Service Card

## Galvanometer

A high-frequency galvanometer which extends the useful recording capabilities of CEC oscillographs to 13,000 cps has been developed by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell.

With the Type 7-365 galvanometer, oscillographs can be used for both "quick-look" monitoring and storage of data at frequencies heretofore attainable only by such equipment as cathode-ray oscillographs and magnetic tape recorders.

The 7-365 has a rated deflection (a-c peak-to-peak) of one inch double amplitude and can be used with all CEC oscillographs having an 11½-in. optical arm.

Total sensitivity variation over the entire frequency range (at rated deflection) is not more than ±5% from the statistically determined frequency response curve.

Useful frequency range is from 0 to 13,000 cps. Sensitivity is 69 ma/in. Maximum deflection (a-c peak-to-peak) is 2 in. Nominal per unit damping is 0.64.

Circle No. 252 on Subscriber Service Card

## Checker/Activator

A Model 610 gas checker and Model 621 getter activator designed to promote optimum use of spare, standby, and operative eimac power klystrons (numbers 4KM50, 000LR, 4kM50, 000LQ,



4KM50, 000LA3, 4KM50, 000LF, 4KM50LB, and 3KM50, 000PA) have been developed by Elsco Systems, Inc. In combination, they provide means of detecting high gas levels in klystrons and of degassing them.

The clamped meter of the checker provides simple go-no-go indication as well as numerical indication of relative gas pressure. The activator is used in a normal or flash mode to degas, employing the klystron's own titanium getter, or by beam pumping. Both units are highly automatic, requiring minimum skill to operate.

Circle No. 253 on Subscriber Service Card

## UHF Power Amplifier

A UHF power amplifier weighing less than one pound and measuring only 12 cu. in. is available from Microdot, Inc. Model 217A, the miniaturized cavity utilizes a single ceramic tube and produces an output of 40 watts from an input excitation of 2 watts. Rapid cooling is accomplished through a heat sink that conducts the heat from the tube to the outer surface of the module. The space saving size of the 217A, which makes it particularly valuable in aerospace applications, is the result of new circuit designs which provide stable, non-critical alignment and rugged reliability.

Circle No. 254 on Subscriber Service Card

## Micro Transistors

The General Electric Co. has developed a line of silicon planar and planar epitaxial passivated transistors designed for use on thin-film microelectronic circuits. The units are composed of a transistor pellet mounted on a Kovar tab measuring 0.050-in. wide and up to 0.10-in. long. In place of the traditional metal transistor cap, an epoxy resin is deposited over the pellet to protect it from mechanical damage. The overall thickness is about 0.030-in.

The transistors are available in either a 2-lead configuration with the Kovar tab serving as the collector lead or a 3-lead configuration for circuits where a collector lead may be desired.

Circle No. 255 on Subscriber Service Card

## Coaxial Cable

Helical membrane, an aluminum sheathed, air dielectric, semi-flexible coaxial cable has been developed by Phelps Dodge Electronic Products Corp.

A lightweight cable, Helical Membrane offers fast propagation, low signal loss, high temperature resistance, low attenuation, excellent frequency response, uniform electrical properties over a wide range of temperature variations and unlimited operating life. Additionally, Helical Membrane may be pressurized to improve voltage ratings and can be bent to very small radii without electrical or mechanical disturbance.

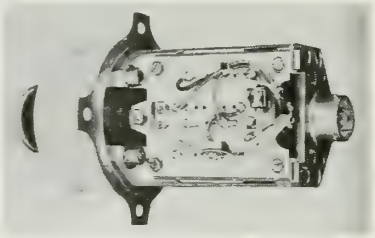
The inner conductor of the cable is copper wire or tube, depending on cable diameter, coaxially supported by a polyethylene helix, sheathed in a seamless aluminum outer conductor. When Helical Membrane is to be used in applications involving temperatures in the 100°C to 250°C range, Teflon helix is substituted for polyethylene.

Circle No. 256 on Subscriber Service Card

## Missile Disarming Switch

Daven Division of General Mills, Inc., has developed a line of disarming switches for use in operational missiles.

The Daven switch is a manual device which, once locked, cannot be dislodged unless a remote control pulse is



deliberately triggered to actuate the missile. As long as the button is pushed in, the unit is absolutely disarmed. When the button is out a red marking on the switch indicates "armed" position.

Circle No. 257 on Subscriber Service Card

## Step Attenuator

A compact "K" Band step attenuator with an extremely wide frequency range has been developed by Guide Manufacturing Co. Model 327—designed for use in radar systems and parametric amplifiers—consists of a metalized mica card attached to a rotary solenoid.

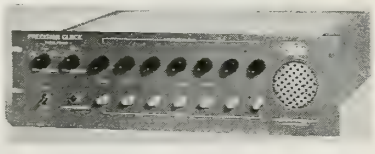
The unit operates on a frequency band of 18.0-26.0 gc. Attenuation is a minimum of 20 db; insertion loss is a maximum of 0.5; VSWR is a maximum of 1.2 and voltage input is 28 vdc.

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## Portable Precision Clock

Aerospace Research, Inc., has developed a Portable Precision Clock weighing 15 lbs. for field and airborne application where battery operation and exceptional stability are a must.

The solid-state PC-110, operating from either a 30 volt rechargeable battery or 110 volt a-c, provides jitterless output in decades from 1.0 microsecond to 1.0 second, and at one minute.



A feature of the ARI precision clock series is a pushbutton stepping switch that permits rapid incremental pulse setting and synchronization to within a microsecond of external primary time references such as Loran-C,

WWV, NBA. An integral one second audio signal may also be activated to enable synchronization of the clock and external source without use of an oscilloscope.

Circle No. 270 on Subscriber Service Card

## Solid-state DC Inverters

All solid-state d-c to sine wave inverters from 400 to 1600 cps are available from Arnold Magnetics Corp., Los Angeles. The 400, 800, 1200 and 1500 cps units are standard, and any frequency from 400 to 1600 cps will be supplied on special order.

Powered from a 28-volt d-c source, these power supplies deliver up to 50 volt-amperes with low harmonic distortion. Units are ideal for driving a-c motors, gyros, and magnetic amplifiers. Output voltage and frequency are regulated to close limits, making units suitable for powering military servo systems from a d-c line.

Units feature self-protection against short-circuits, input line transients, and reversal of input polarity. Frequency stability is 0.5%.

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## Logarithmic Detector

Deveolped by Electronics Systems, Inc., Model 129 logarithmic detector features wide bandwidth, high gain, and calibrated input-output characteristic. A minimum IF bandwidth of 10 mc is achieved with all stages synchronously tuned. The output video passband is from d-c to 3.5 mc.



The input dynamic range is 60 db. and the peak pulse output level varies from plus one to plus six volts over this range of input signals. The input-output characteristic is held to within plus or minus 1 db of a logarithmic curve.

This unit employes eight vacuum tubes and includes a linear detector for alignment purposes.

Circle No. 261 on Subscriber Service Card

## Magnetic Testers

Two models of precise magnetic testers, specifically designed for the evaluation of magnetic cores and circuits, are available from Electronic Memories, Inc. The design utilizes four basic, interchangeable modules; negative drivers, positive drivers, current calibrator and a program generator to achieve flexibility of usage. A power supply module is used with all versions of the testers.

Where a variety of tests and programs is to be performed, Model 150, which includes the program generator module, allows toggle-switch control of programs from the front of the unit. For more static requirements, Model 102, which has no program generator and requires manual repatching of banana plugs located at the back of the unit to accomplish program changes, is adequate.

Circle No. 262 on Subscriber Service Card

## Current Input Conditioner

B&F Instruments, Inc. is marketing a unit for conditioning variable-resistance transducers. The Model ICI601 Conditioner accommodates conventional strain gage transducers as well as transducers that undergo changes in


THERE'S ACTION IN ROCKETS AT BELL AEROSYSTEMS

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Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

**INDUSTRIAL SECTION:**
Detailed listings of major missiles/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

**COMPANY REPRESENTATIVES SECTION:**
Listing company representatives stationed in Washington and in most strategic missile/space areas.

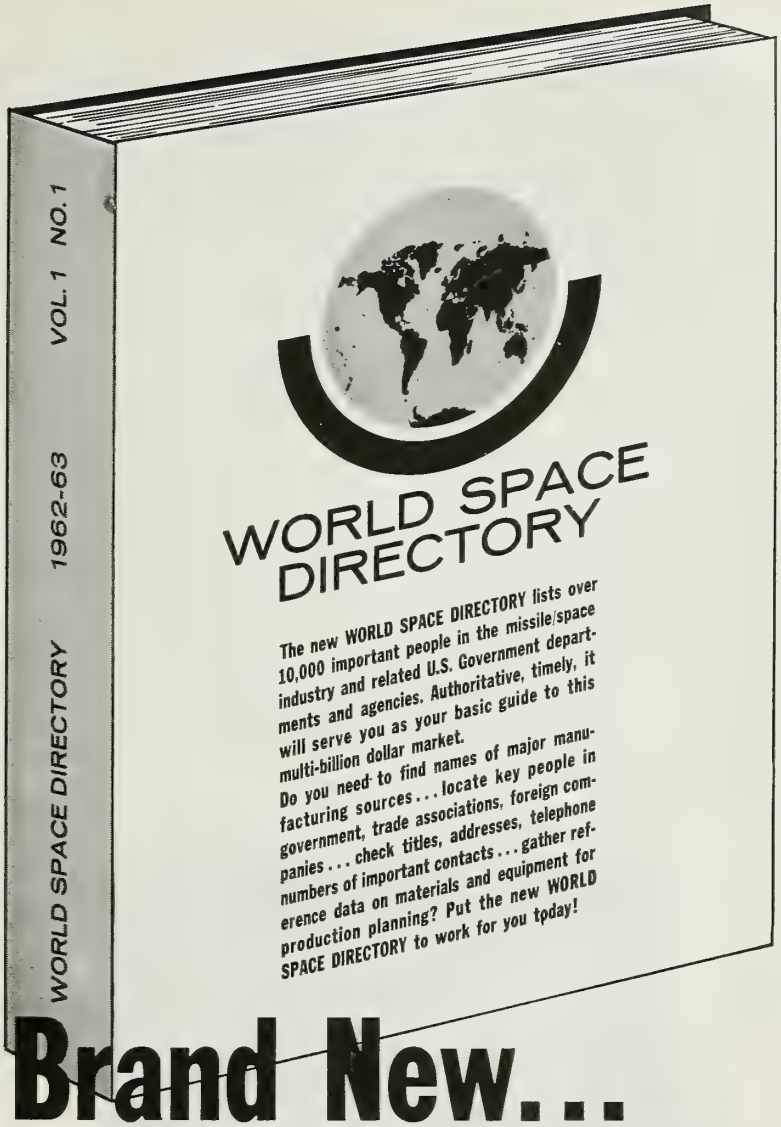
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resistance, such as temperature probes, potentiometers, semiconductor strain gages and asymmetric strain gage bridge configurations.

A highly stabilized constant current supply provides transducer excitation. Constant sensitivity can be maintained in a 4-wire system regardless of cable length and resistance change. The output impedance is at least 2 megohms and the current will vary less than two parts in 10,000, even if a 350-ohm bridge is shorted.

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## Slang Computer

A "common language" computer which uses existing program libraries without reprograming, duplicates the commands and formats of other computers, and enables programers to create problem-oriented command lists will be marketed by Packard Bell Computer. The PB440 employs a dual memory stores logic concept which stores commands in the form of microcommands in an ultra-fast logic memory. Commands can be changed as required, giving the computer unusual flexibility and efficiency. In addition to the logic memory, which executes microcommands with a 1 microsecond read time, the PB440 utilizes a conventional main memory operating on a 5 microsecond cycle time.

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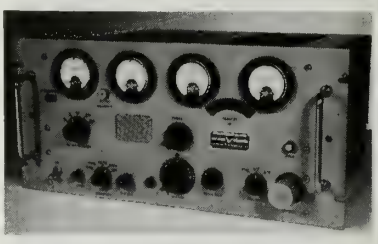
## Bandpass Filters

A series of interdigital bandpass filters for microwave applications is available from MELABS. The filters are being marketed with center frequencies from 100 mc through 10 gc, with bandwidths ranging from 1% to more than an octave. Phase tracking is better than 2 degrees from unit to unit, opening up many new filter uses. The line offers high performance, temperature-stable microwave bandpass structures with extremely low loss (typically 0.3 to 0.7 db for 12-section filters), and clean stopband characteristics.

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## UHF Telemetry Receiver

Defense Electronics Inc. is marketing the TMR-21 UHF telemetry receiver. The unit has been designed to fill the need for a versatile receiver in the 2200-2300 megacycle band that will not only meet standard FM/FM and PDM/FM applications, but PCM/FM requirements as well in systems using up to one million bits per second. Key features of this receiver include VFO or crystal controlled one knob tuning and complete predetection record and playback capabilities. The combination of plug-in IF amplifiers to determine predetection bandwidth, simultaneous

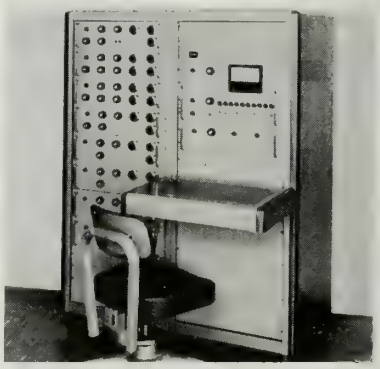


FM and AM detection and adjustable video bandwidth make the receiver suitable for use in the ground station of virtually any telemetry system currently used.

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## Semiconductor Check

Rapid, accurate, semi-automatic checking of transistors, diodes and other devices is available from Owen Laboratories, Inc. in its series 1000 semiconductor test equipment. The unit is capable of handling components in extremely large quantities and is also economical for moderate quantities and for



engineering and reliability studies. Designed in the building block concept, each test module is completely independent with its own power supply and may be used alone or in combination with other modules. Only a readout device is required to complete a simple test set-up. Basic units include a scanner, limit comperator and indicator. Full scale output on each range is one volt for all parameters, which can be easily fed into digital equipment.

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## High Temperature Solenoid

A high-temperature solenoid developed by Whittaker Controls and Guidance Division of Telecomputing Corp. is an electric valve actuator for space application and operable on 400-cycle ac power. The unit is independent of space environments and altitude conditions.

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# —when and where—

## DECEMBER

**Fall Joint Computer Conference, sponsored by American Federation of Information Processing Societies and IRE,** Sheraton Hotel, Philadelphia, Dec. 4-6.

**Vehicular Communications Conference, IRE,** Disneyland Motel, Los Angeles, Dec. 6-7.

**First Annual Symposium on Unconventional Inertial Sensors,** Republic Aviation Corp.'s Paul Moore Research & Development Center, Farmingdale, N.Y., Dec. 10-11 (classified).

**Pricing and Negotiating Prime and Subcontracts and the Defense and Aerospace Industries Seminar,** Marriott Motor Hotel, Washington, D.C., Dec. 10-15.

**Structural Dynamics Under High-Impulse Loading Symposium, sponsored by AFOSR (Mechanics Div.) and Aeronautical Systems Div., Wright-Patterson AFB,** Ohio, Dec. 17-18.

**International Arms Control Symposium, sponsored by University of Michigan and Bendix Systems Div.,** University of Michigan, Ann Arbor, Dec. 17-20.

**Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science,** Philadelphia, Dec. 26-31.

**American Astronautical Society Symposium on Scientific Satellites—Mission and Design,** Franklin Hall, Philadelphia, Dec. 27.

## JANUARY

**Millimeter and Submillimeter Conference, IRE,** Cherry Plaza Hotel, Orlando, Fla., Jan. 7-10.

**American Chemical Society National Meeting,** Cincinnati, Jan. 13-18.

**Automotive Engineering Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Jan. 14-18.

**Ninth Annual American Astronautical Society Meeting,** Statler Hilton Hotel, Los Angeles, Jan. 15-17.

**31st Annual Meeting, Institute of the Aerospace Sciences,** Hotel Astor, New York City, Jan. 21-23.

**43rd Annual Meeting, American Meteorological Society,** New York City, Jan. 21-24.

**Ninth National Symposium on Reliability and Quality Control,** Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

**Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn.,** International Inn, Washington, D.C., Jan. 28.

**Fourth Annual Solid-Propellant Rocket Conference, American Rocket Society,** Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

## FEBRUARY

**Symposium on Engineering for Major Scientific Programs,** Georgia Institute of Technology, Atlanta, Ga., Feb. 5-6.

**Electronic Sales-Marketing Assn., First Annual Convention,** Americana Hotel, New York City, Feb. 11-13.

**Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques;** UNESCO Building, Paris, Feb. 11-15.

**Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical System Div.'s Flight Accessories Laboratory,** Engineers Club, Dayton, Ohio, Feb. 12-13.

**1963 International Solid State Circuits Conference, sponsored by IRE, AIEE and University of Pennsylvania,** Philadelphia, Feb. 20-22.

## MARCH

**1963 Microminiaturization Congress,** Sheraton Hotel, Philadelphia, March 5-7.

**Propulsion Meeting, Institute of the Aerospace Sciences,** Cleveland, March 7-8.

**Chemical Engineering in Space Technology Symposium, sponsored by the American Institute of Chemical Engineers,** New Orleans, March 10-13.

**Electric Propulsion Conference, sponsored by the American Rocket Society,** Broadmoor Hotel, Colorado Springs, Colo., March 11-13.

**Space Flight Testing Conference, sponsored by the American Rocket Society, and Institute of the Aerospace Sciences,** Cocoa Beach, Fla., March 18-20.

**1963 Western Metal Exposition and Congress,** Pan Pacific Auditorium and Ambassador Hotel, Los Angeles, March 18-21.

**Second Symposium on Bionics, sponsored by the Air Force,** Biltmore Hotel, Dayton, Ohio, March 19-21.

**Institute of Radio Engineers International Convention,** Waldorf-Astoria Hotel and New York Coliseum, New York City, March 25-28.

## APRIL

**Fourth Annual Structures and Materials Conference, American Rocket Society and Institute of the Aerospace Sciences,** El Mirado Hotel, Palm Springs, Calif., Apr. 1-3.

**Fourth Symposium on Engineering Aspects of Magnetohydrodynamics,** University of California, Berkeley, Apr. 10-11.

**Hypersonic Ramjets Conference, American Rocket Society and American Society of Mechanical Engineers,** Naval Ordnance Laboratory, White Oak, Md., Apr. 15-17.

**Symposium on Thin Films for Electronic Application, sponsored by the Electrochemical Society,** Pittsburgh, Apr. 15-18.

**International Nonlinear Magnetics Conference, sponsored by the AIEE and IRE,** Shoreham Hotel, Washington, D. C., Apr. 17-19.

**Institute of Environmental Sciences 1963 Technical Meeting and Equipment Exposition,** Statler Hilton Hotel, Los Angeles, Apr. 17-19.

**Southwestern Conference and Electronic Show, IRE,** Dallas Memorial Auditorium, Dallas, Tex., Apr. 17-19.

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# A Stag at Bay

ONE OF THE MOST incredible dialogues between industry and government ever to go on the record was a prelude to last week's strike decision at Lockheed Aircraft Corp. (see p. 9).

We propose to examine it here at some length, first because the Administration's shocking misuse of its powers should be fully recorded, and second, there are some harsh lessons in it for this industry.

It is plain that President Kennedy and his staff decided to keelhaul Lockheed in open view as an object lesson to the remainder of the business community.

The fact that this was done to support a stand which already had been rejected by both business and labor—and we mean labor, not labor management—made it even more shocking.

First, let's look at the background.

A Presidential Board headed by Dr. George W. Taylor was named by Mr. Kennedy on July 21 to act in labor negotiations which included North American Aviation, Ryan Aeronautical, General Dynamics/Convair and Lockheed.

Dr. Taylor is a professor of labor relations at the University of Pennsylvania. But he prefers to think of himself primarily as an arbitrator, a field in which he has been active for many years. He has written or edited several books on labor relations and served, among other things, on the Presidential Board which inquired into the 1959-1960 steel dispute.

On the issue of union membership, the Taylor Board recommended a vote of company employees. There was not, and it is important to remember this, a single one of the companies which was in favor of such a procedure.

Strong pressure—including a scathing attack by the President himself—was brought to bear. With the exception of Lockheed, all the companies knuckled under to the demand for a vote.

Provision for this vote was made a part of the new contracts. In rapid succession, workers at North American, Convair and Ryan voted it down. This also is important to remember.

In a similar situation, Boeing Co. went along with plans for a vote by its employees but refused to make this part of a new contract or be bound by the result. Boeing made it clear that it was against such a vote. Remember that, also.

Lockheed alone refused to put the matter to a vote, despite the fact that the President pointedly had called attention to the dependence of the industry on defense contracts. President Kennedy, the company pointed out, was by-passing the proper routes established by Congress for labor settlement.

That is the background. Then, on November 17, came one of the most amazing documents ever issued by the Pentagon. It was an official Dept. of Defense news release. It noted that the other members of the industry had accepted the recommendations of the Taylor Board, as had the unions. Then it stated:

"Lockheed stands alone in refusing to follow the course that the other members of the industry considered reasonable. The President in his press conference on September 13 pointed out, following acceptance of the Taylor Board proposals by the unions involved, that the responsibility for any strike that might take place in this industry would be clear to the American people."

The release then noted that DOD was considering alternate means of production in the event of a work stoppage at Lockheed.

The Administration had quite brazenly bared its willingness to use government contracting powers to force its demands on Lockheed. In addition, it was not above distorting the facts. The other members of the industry did not consider the vote reasonable—and had made that clear. They bowed to it under pressure.

IN A FULL-PAGE newspaper advertisement on November 21, Lockheed clearly stated its reasons for refusing to go along with the proposed election:

"We believe that every employee should have the freedom to join or not to join a union, as he sees fit. We believe this is a basic American freedom—like freedom of worship and freedom of speech and freedom to take a new job or move to a new community—that must not be voted away."

The statement was signed by chairman Courtlandt S. Gross and president Daniel J. Haughton.

On November 23, a DOD spokesman swung another blow. No new Defense Dept. contracts would go to any Lockheed division without approval at the highest level. Specific contract approval would be required, at the very least, from the secretaries of the Army, Navy and Air Force.

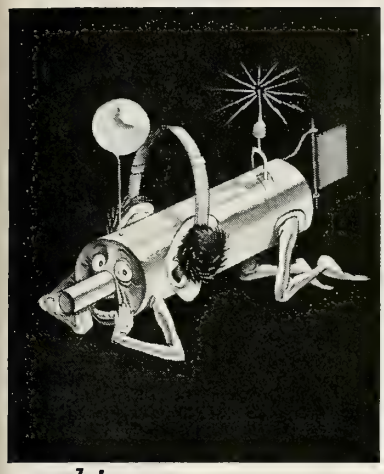
Lockheed, standing alone, was being battered with every weapon. President Kennedy's object lesson to business was being made clear: "This, gentlemen, is what happens when you oppose us."

But, whatever happens to Lockheed, we hope the industry has learned another lesson as old as the Republic: "United we stand, divided we fall."

What, we wonder, would have happened if all the companies had shown Lockheed's fighting courage on this issue?

**William J. Coughlin**

*preamplifiers*



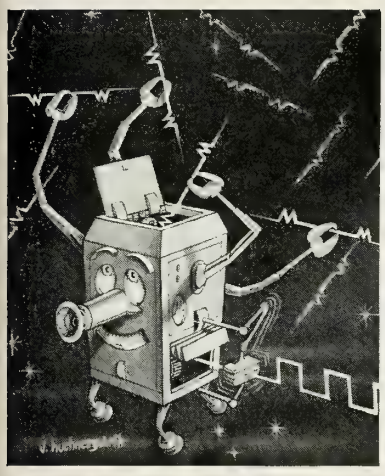
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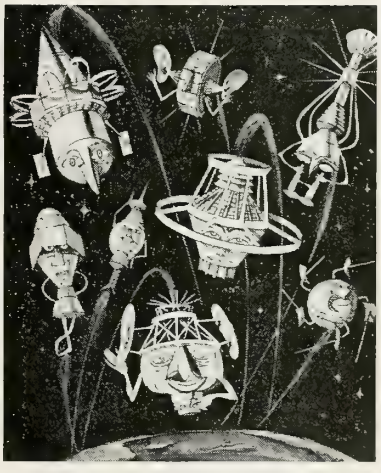
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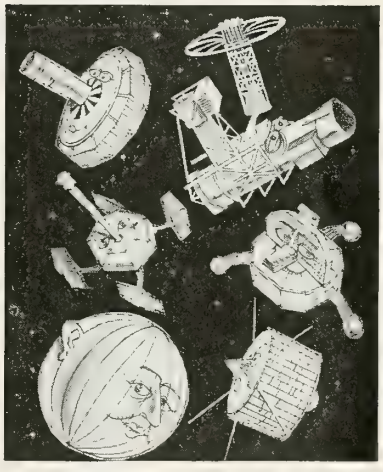
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Historically, Nems-Clarke products have served the military, and they have been used in every major space project. To this backlog of engineering experience, Vitro Corporation added a team of research mathematicians from its West Orange Laboratories. This combination of divisional capabilities developed the new modular receiver concept of the 1037.

Again, the varied divisional capabilities of the Vitro Corporation have worked together to find better ways that cost less. This application means progress in space communications.

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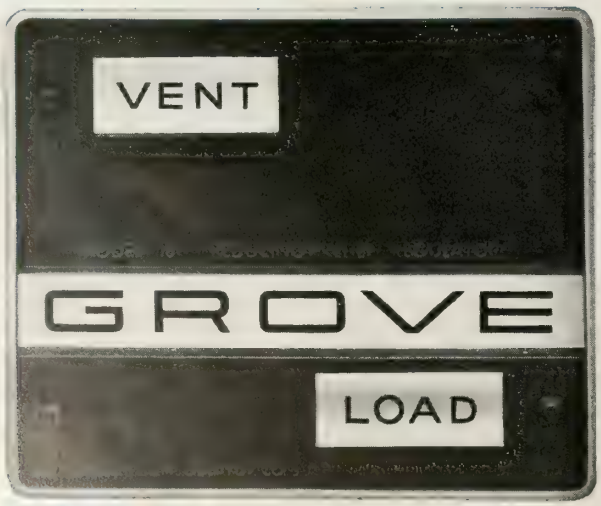
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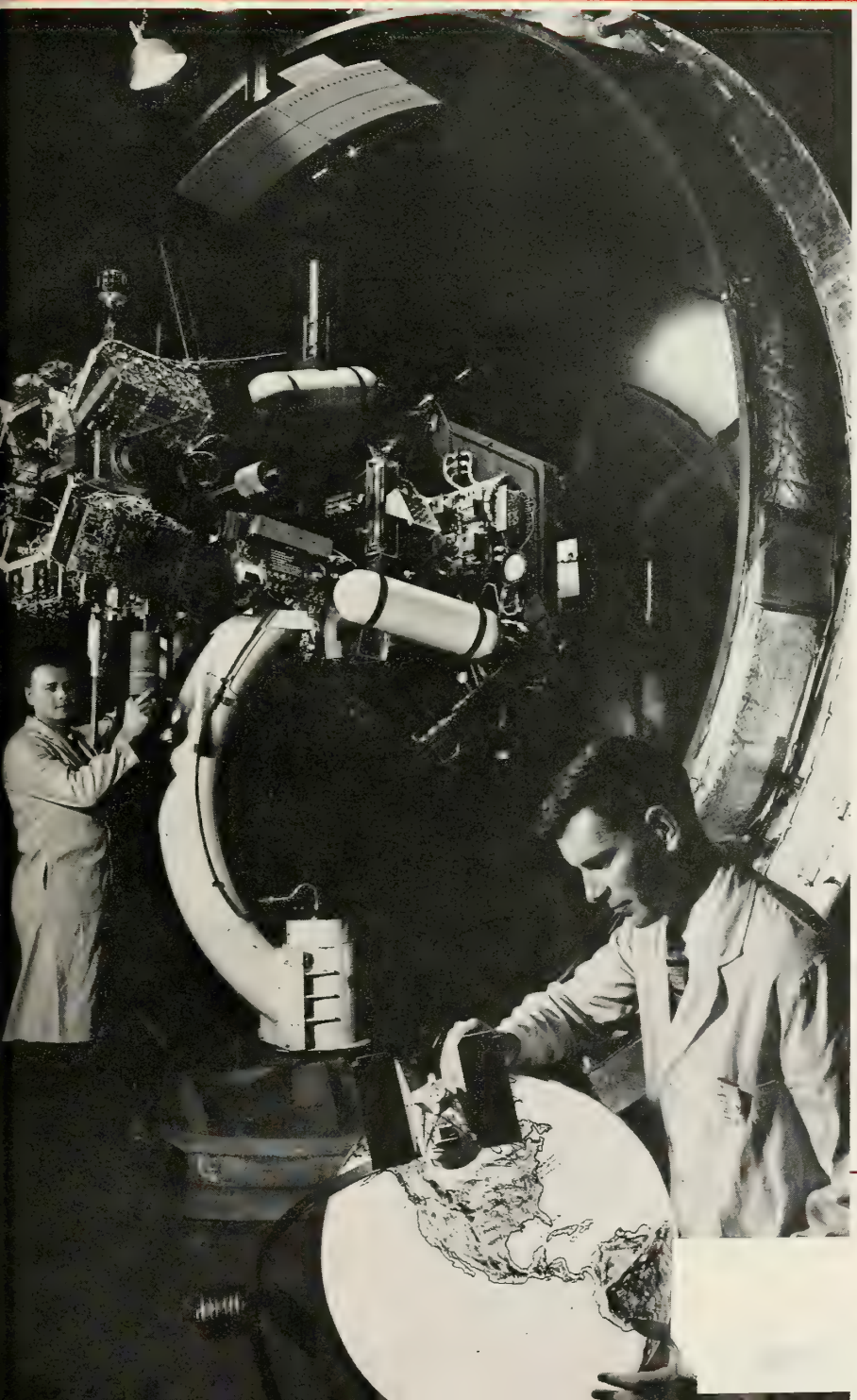
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

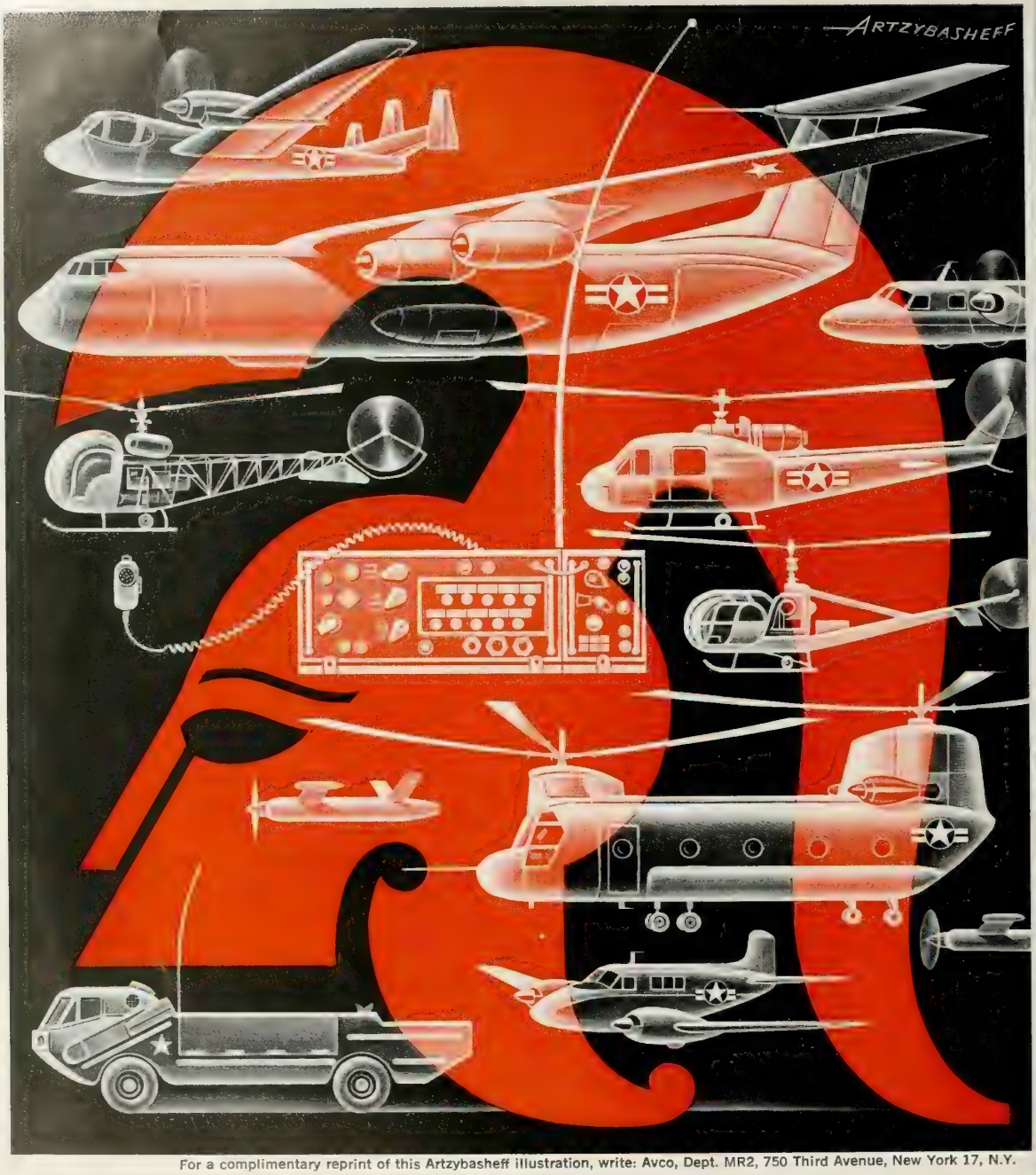


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## SAINT Reoriented To Advanced System

- RFP's Nearing For DOD ComSat
- SNAP Probe Now Under Way
- Grumman Gears Up For LEM Work

*Checking Nimbus Controls*




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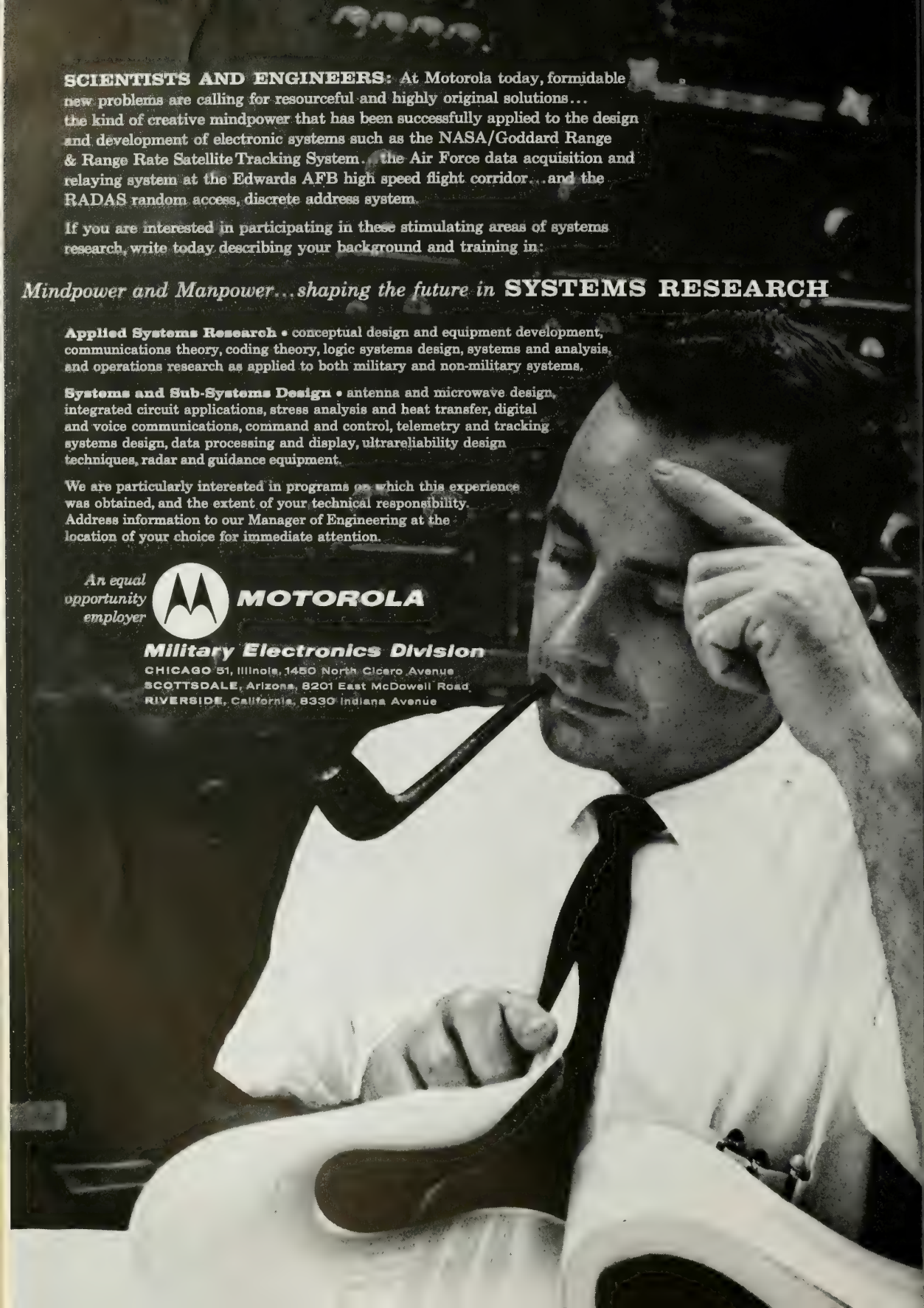
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 24 December 10, 1962

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## THE COVER

*Prototype of NASA's Nimbus meteorological satellite gets three-axis test at GE's Valley Forge, Pa., facility to check out stabilization control system. Engineer in foreground watches scale model and Earth horizon simulator.*



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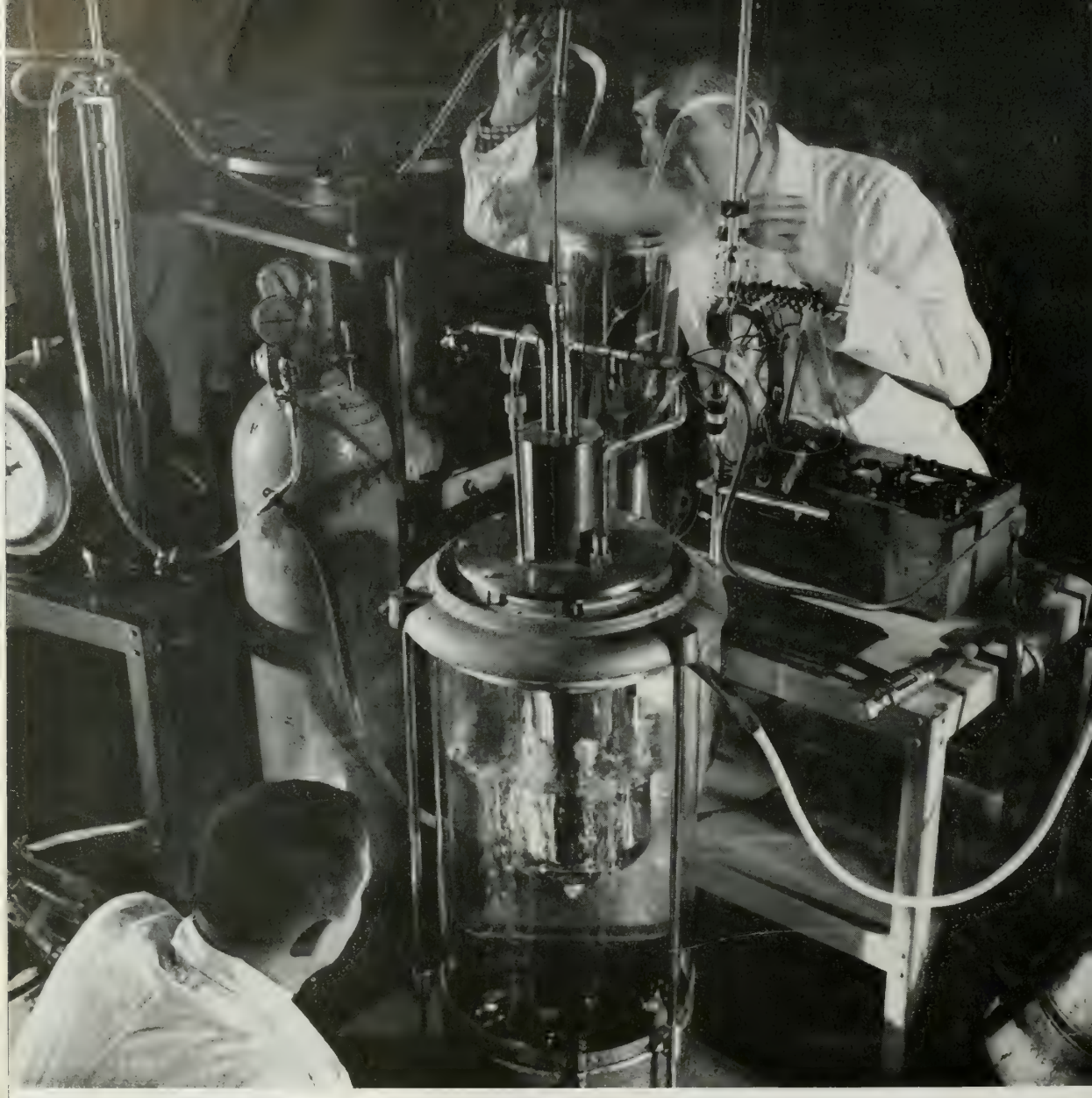
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† U.S. Reg. Pdg.

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# Beech helps space vehicles get better mileage by turning "hot" fuel into icy slush

## *Slush hydrogen experiment shows vital facet of Beech's comprehensive systems management capability*

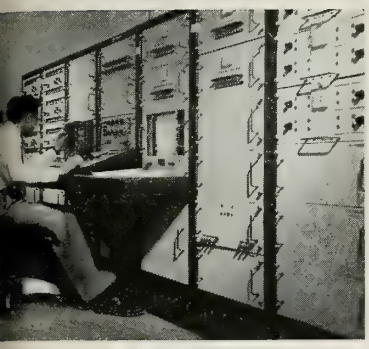
At the heart of this experiment at Beech's Boulder, Colorado, space center are three double-walled vacuum jars, each inside the other. Inside the inner jar is liquid hydrogen, while the center jar contains liquid helium. The outer jar is filled with liquid nitrogen. The idea is to further reduce hydrogen temperature until it turns to icy slush.

The purpose of this experiment is to explore the feasibility of reducing hydrogen volume in order to increase space vehicle fuel loads without increasing tankage size or weight.

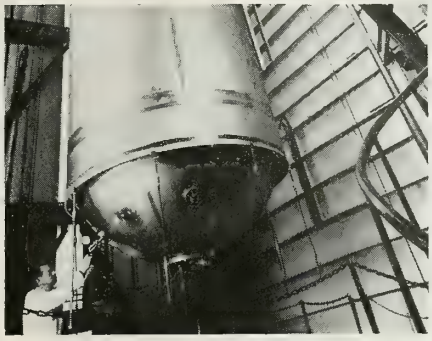
Applied research projects like this are common at Beech. In the past they have included valuable work on cryogenic problems, space environment, and countless other projects that have measurably advanced the state of the art.

Basic research and development is but one of an ever-expanding group of Beech space-age capabilities. Within the last year alone, the size and function of Beech space facilities has more than doubled. This constantly expanding capability complex, coupled with a highly trained and experienced staff, makes Beech a natural choice for systems management projects. Besides the experiment shown here . . .

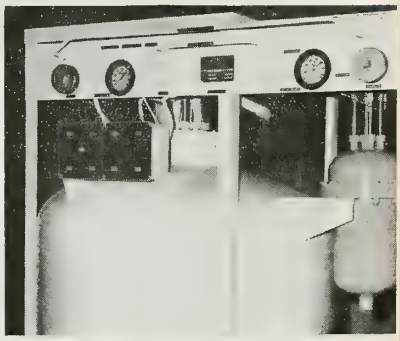
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***R & D...***



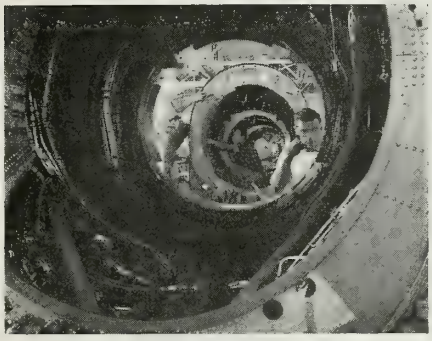
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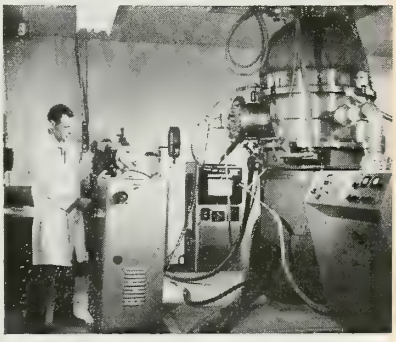
***Auxiliary Power...***




***GSE...***



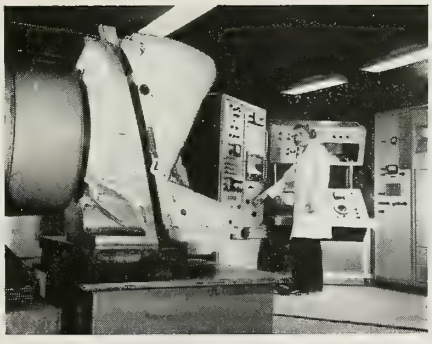
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# letters

## Lockheed's Struggle

*To the Editor:*

Congratulations on your Dec. 3 editorial, "A Stag at Bay."

While our organization does not directly have to face a problem similar to that of Lockheed, North American, Boeing and others, the basic issue is such a fundamental one to our freedom and the American concept of self-determination, I felt compelled to drop you this brief letter.

The use of such pressures by the Administration is contrary to the spirit and intent of Government and contrary to the law of the land and the Constitution.

Fortunately Lockheed is so involved in DOD contracts that cancellation or even threatened "no more business" would cost the taxpayer so many millions, I doubt that even Kennedy would try it.

Keep speaking your piece!

David Early
Secretary-Treasurer
International Avionics, Ltd.
Washington, D. C.

## Second NASA Issue

*To the Editor:*

We are very much interested in your second annual issue devoted to the National Aeronautics and Space Administration. We are ordering 150 copies. They will be sent to our offices in foreign countries for use in the information program. Since many of our offices may want to reprint material from the issue and give it to foreign editors for use in the local press in other countries, may we have blanket permission for republication of textual material relating to NASA (in English and in translation) by all U.S. Information Service offices and the local press outside the United States and Canada? Credit, of course, will be given to MISSILES AND ROCKETS.

Garrett K. Sias, Chief
News and Features Branch
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Washington, D. C.

*Permission granted.—Ed.*

## The Ethics of Fame (cont'd)

*To the Editor:*

May I submit that your editorial is unjustly severe with the astronauts. It is also somewhat contradictory. For example: if there is nothing intrinsically wrong in selling an article to a magazine, then please help the misguided astronauts by suggesting how the half-a-million dollars should have been (obtained) in a more ethical manner.

You are pointing vaguely at the true cause of these actions, that you find so repugnant, namely the complete and devastating disregard by the fourth estate for the privacy of the individual. But you fail to criticize fully the fact that the press very often *demands* to know all the intimate details about the family life of a person in the public spotlight. I can easily imagine the self-righteous cries of the reporters that "the public has a right to know," if one of the seven had tried to shield his private life from the glare of publicity.

"Mental cruelty" is a tremendously overworked label, but it is a very proper description of the treatment of the parents and immediate families of Glenn, Carpenter and Schirra. What chance was there for them to escape the siege of their homes by an army of reporters and TV trucks? They did not have to mobilize great resources of courage, they just had to watch in the agony of helplessness and inactivity and then immediately face the reporters armed with microphones and cameras to expose their innermost feelings. I sincerely hope that the financial rewards rub off on them. . . .

As for the loss of The Ethics of Fame, that occurred a long time ago through the actions of the Great American Press and the consent of the Great American Mob. . . .

Finally, may I also suggest that the situation faced by the astronaut is not quite similar to that of a soldier or a combat pilot as far as personal courage is concerned. The combat pilot usually is the complete master of a machine with which he himself has obtained some operational training and the perils he has to face can easily be imagined. But the astronaut, after having overcome the basic fear of something almost entirely unknown, then has to submit to a machine over which he has very limited control. . . .

Sture Folkesen
Bellevue, Wash.

*To the Editor:*

Your editorial came as a thought-provoking surprise.

I cannot agree that to "cash in" on fame is to be decried. If the financial rewards can be had without specific detriment to others, has a wrong been done?

To be sure, the selflessness of the man who can turn down the gifts of an admiring populace is to be praised. But this is a man head and shoulders above the crowd, one who was not singled out by man-conceived tests but by fate.

To my knowledge, the claim has not been made that the astronauts are exceptional. They are select, they have had unique training . . . but are they heroes? Can men select or make heroes?

The astronauts have a job. They perform the job for which they have been trained. They are not the only ones capable, nor the only volunteers. They are those lucky enough to have been given the opportunity. It is the public and the mass media who have glorified space. It is the comparison of the first space flights to the explorations of Columbus and Magellan that has added the aura of romance. It is the deplorable American

drive to associate either physically or mentally with the celebrities that has generated the financial sacrifice which even gods with feet of gold accept.

Reader Bross's rationalization (Letters, M/R, Nov. 26, p. 7) that what Columbus did is correct for all justifies nothing. Similar reasoning, that history leads the way, will never assist our astronauts in usurping the throne of Selene.

John W. Juechter, Jr.
N. Wilbraham, Mass.

*To the Editor:*

Just how ethical "The Ethics of Fame" should be judged as an individual public expostulation is a matter of opinion, but there can be little doubt of its merit on the rebound. The candid but aptly restrained comments of Bross, Monroe and Wooddell in the Nov. 26 Letters column have probably warmed the hearts of more readers than the Editor reaches during the entire battle for a budget. It is to be hoped that the astronauts themselves have wisely held their counsel during the contentious exchange.

P. L. High
State College, Pa.

## The LEM Competition

*To the Editor:*

Just how much politics did enter into the selection of a contractor for the Lunar Excursion Module?

First, President Kennedy stated that he was going to spread the space work around the country. This is fine, but let's not jeopardize the space race for so-called economic reasons in some part of this country (or maybe they are campaign promises). I doubt if any part of this country is that weak economically.

Second, I quote verbatim the following item from M/R, July 16, p. 9:

"Industry reports that NASA has ruled against award of the two-man lunar shuttle vehicle contract to any West Coast firm are denied by the space agency. Proposals will be asked from all areas of the country, according to NASA officials. Despite this, contract is expected to go to an East Coast company."

Third, there was another, similar remark made around this time in either *Aviation Week or* MISSILES AND ROCKETS, but I must admit I could not find it in going back over some of my past issues.

Thus, was the LEM contract "fixed" before proposals went out, or was it a coincidence that an East Coast firm did get the contract? If the former is true, this method of selecting contractors for space work is bound to lessen the competitive spirit of the engineers working on these particular proposals.

I agree, the above is not strong evidence that this contract was "fixed," but the evidence is strong enough to make me wonder.

Larry L. Lakamp
Los Angeles, Calif.

*Grumman Aircraft Engineering Corporation was reported to be first in the LEM technical competition.—Ed.*





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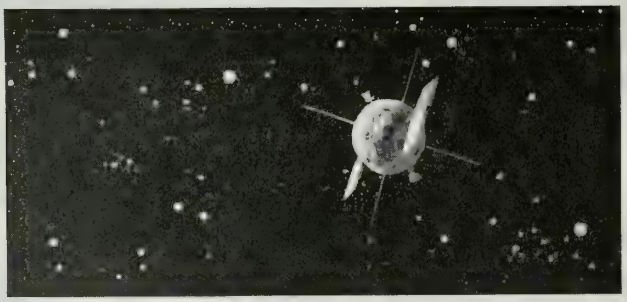
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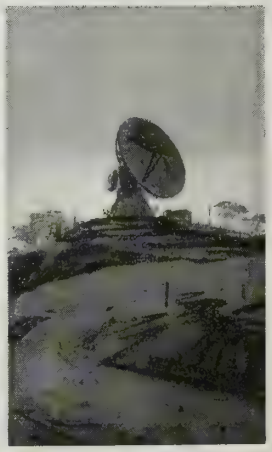
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# The Countdown

## WASHINGTON

### DOD Briefed on Military Space Programs

Top-level Dept. of Defense brass received an Air Force technical briefing last week on current military space programs, including *SAMOS, MIDAS* and *SAINT*. The session was not a budget review.

### Army Seeking Geodetic Satellite

Army Corps of Engineers at Fort Belvoir, Va., is now evaluating proposals from industry for a geodetic satellite to be compatible with the Army's radio-ranging SECOR unit. SECOR currently is one of the three systems aboard the *ANNA* satellite. The proposal requests called for delivery of a satellite vehicle by next Feb. 1.

### AF Ready to Ask Big Solids Bids

Dept. of Defense is expected to select as many as four contractors for its big solid motor program. Requests for proposals have been completed by Air Force and are to be issued this month. Firms will be allowed six to eight weeks to prepare proposals. The 2½-to-3-year program calls for development and test of both half-length and full-length 260-in. motors.

### NASA Biomed Program Up for Approval

The space agency's *BIOS* program, which calls for launch of chimpanzees and other forms of life for extended periods, now is in the office of Associate Administrator Robert C. Seamans for approval. NASA's current budget squeeze could force some delay—although an okay is expected.

### Thumbs Up for Troubled Ranger

The special committee studying NASA's *Ranger* program has given it a vote of confidence. The group submitted its report last week to the Office of Space Sciences. The committee was set up after five straight failures in the Moon shot program. Among its recommendations: certain minor design changes, together with steps to achieve better reliability and control. This probably means a short delay in the *Ranger VI* launch, now set for the first quarter of next year.

### Missile Programs Move Ahead

Two big U.S. missile programs currently are taking a giant step forward. The first Wing I *Minuteman* base at Malmstrom AFB, Mont., becomes operational this week. And at Davis-Monthan AFB, Ariz., the first *Titan II* has been mated with its silo less than nine months after its first test firing at Cape Canaveral.

### NASA to Ask New DSIF Antenna Bids

New bids will be requested by NASA for three 210-ft. antennas. The space agency was not satisfied with original bids submitted on the development contract for antennas at its Deep Space Instrumentation Facility tracking stations. Specifications have been reworked. New bids will be requested by early 1963. First antenna is to be built at the Goldstone, Calif., station.

### Army Is Studying Derringer Missile

A small, multi-purpose, solid-fuel missile which could be fired from aircraft, ground vehicles or on foot against both airborne and ground targets is under study by the Army. Called *Derringer*, the weapon is expected to be simple enough to be handled as a conventional round of ammunition.

### ADC Wants Space Weapons System

Air Defense Command now is making it clear it ultimately favors area defense weapons, as opposed to point defense systems like *Nike-Zeus*. This requires interception closer to the launch site than to the target. Maj. Gen. Arthur C. Agan, ADC planning chief, pointedly notes that a spaceborne weapons platform is the only feasible system for this purpose.

### Cold Spell on Pennsylvania Avenue

White House officials are somewhat annoyed at NASA Administrator James Webb's announcement of the decision not to seek a Fiscal '63 supplemental appropriation. It's up to the President to make such decisions, they point out. The public announcement also leaves little room for a graceful retreat if future events force a change in plans.

## INDUSTRY

### Thiokol Seeks Apollo Maintenance Contract

Humetrics Division of Thiokol Chemical is preparing an unsolicited proposal to NASA for a study of ways to perform space maintenance on *Apollo* modules which would not require astronauts to leave their vehicles. The proposal may attract interest if the *Gemini* stretchout threatens plans to demonstrate ability of astronauts to work outside of spacecraft. Study also covers the *S-IVB* final *Saturn* stage.

### Ford President Proposes Industrial Guard

Ford Motor Co. President John Dykstra believes an industrial National Guard should be established to keep the heavy manufacturing industry in a state of preparedness to switch from peacetime to wartime production. He made the proposal to military brass at last week's American Ordnance Assn. meeting in New York.

### New Missile Trajectory System Near

First demonstration of Diamond Ordnance Fuze Laboratory's new three-dimensional missile trajectory measurement system, developed for the Army Electronics Command, is scheduled for next summer. The system is designed to provide complete trajectory coverage down to 100-ft. altitude with a space position accuracy of ±10 ft. System is outgrowth of work on a precision altimeter for *Pershing* flight test analysis.

## INTERNATIONAL

### Red China Gains in Electronics

Six members of Britain's Royal Society who toured Red China last month report that country is making strong gains in solid-state physics and electronics. The British scientists say the Chinese might well draw ahead of the West in these fields in the next five to ten years. Their report is carried in the current issue of the British magazine *Discovery*.

### Creation of ESRO Is Postponed

Establishment of the European Space Research Organization (ESRO) has been postponed at least until July of next year. Seven countries still must ratify the proposal for the organization.

SYSTEMS PROGRESS



PRECISION OPTICAL SYSTEMS FOR AIRBORNE-RADAR SIMULATION

The Electro-Optical Department of Consolidated Systems Corporation is now producing the optical system for a complex simulator that displays airborne radar returns from a moving photographic film.

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# The Missile/Space Week

## Space Cooperation Promising

The U.S.-Soviet Union agreement on space cooperation may eventually lead to international weather and communication satellite systems.

While details of the agreement must still be worked out, the systems are the stated goals of the memorandum of understanding between the two nations.

In its early stages, the bilateral agreement provides primarily for the exchange of data in the meteorological satellite, passive communication and geomagnetic survey areas.

In the weather area, the first stage calls for the exchange of cloud-cover, weather-chart and other information obtained from each country's experimental satellites. The second stage—beginning in 1964-65—will include coordinated launchings by both nations of a system of operational weather satellites.

World Geomagnetic Survey—Each nation will launch one earth satellite during the International Year of the Quiet Sun (1964) and data on the magnetic measurements will be exchanged.

Communications—Both nations will cooperate in experiments which will be bounced off the U.S. *Echo II* passive communications satellite, which will be launched early in 1963. Further consideration will be given by both countries to participation in experiments using active communication satellites and the possibility of an experimental global system of space communications.

## Shots of the Week

The Army reported two successful launches of its *Nike-Zeus* anti-missile missile:

On Nov. 29, the missile intercepted an electronically simulated target in a development test at White Sands Proving Ground, N. M. All three solid-fuel rocket motors of the 48-ft. missile fired as planned during the test, the Army said.

In a launch over the Pacific Missile Range Nov. 28, *Nike-Zeus* was shot outside the atmosphere and successfully maneuvered with controlled blasts of rocket exhaust.

In other recent launches:

• A *Nike-Hercules* missile exploded over McGregor Missile Range, Tex., Dec. 4, killing a French lieutenant and injuring four other persons. A range safety officer reportedly blew up the missile at an altitude of 500 ft. when it veered off course. Security officials at McGregor withheld details of the accident, including names of the dead and injured.

• The Air Force shot another secret satellite into orbit from Vandenberg AFB Dec. 4. The satellite—believed to be of the *Discoverer* series—was launched by a *Thor-Agena* booster. This marked the 100th launch of *Thor* as a space booster. Of these, 93 launches have been credited as successful.

• NASA successfully launched two sounding rockets—a *Nike-Cajun* and a *Nike-Apache*—from Wallops Island Nov. 30, initiating a five-nation cooperative series aimed at measuring upper-atmosphere conditions. The other countries taking part are Argentina, Australia, Canada and France.

• The final R&D *Atlas F* launch was made "very successfully" in a 5000-mi. ride to a target area near Ascension Island Dec. 5.

Of the 153 *Atlas* shots to date, 87 were R&D program launches. Of these, 59 were successful, 20 were partially successful and eight were failures.

• The Air Force successfully fired a Martin *Titan I* ICBM 4000 miles down the Pacific Missile Range from Vandenberg AFB Dec. 5, in a test of recently modified ground support equipment.

## ARS/IAS Merger Voted

The American Institute of Aeronautics and Astronautics (AIAA) will begin operation Feb. 1, 1963, with approximately 36,000 members. The new body resulted from merger last week of the American Rocket Society and the Institute of the Aerospace Sciences.

Sixty percent of the ARS members voted on the consolidation issue, with 85% favoring it; 65% of the IAS voted, of which 94% approved consolidation.

## Relay Poised for Launch

The U.S. will attempt this week to launch its second active communications satellite.

NASA's low-altitude *Relay* satellite is scheduled to be boosted by a *Delta* launch vehicle into an orbit ranging from 800 to 4500 statute

miles no earlier than Dec. 13.

The 172-lb. spacecraft is 33 in. high and about 29 in. in diameter.

International television, two-way telephone, teletype and high-speed data experiments will be conducted between stations in U.S., Europe, Brazil and Japan.

## Military R&D Outlay To Drop

U.S. Fiscal Year '64 expenditures for military R&D are likely to be sharply reduced from their current all-time high of $7.1 billion (roughly 15% of the FY '63 military budget).

Speaking in New York last week at the American Ordnance Assn. meeting, Dr. John L. McLucas, Deputy Director of Defense Research and Engineering, reported, "Total R&D expenditures in the country for military purposes have continued to rise faster than the gross national product for several years. We believe that the bulk of this growth has already taken place and that the next few years, barring some unforeseen events, will see a growth rate in military R&D more nearly equal to the expansion of the economy as a whole."

Though no official figures are now available, observers estimate the FY '64 military R&D budget at about 5% of total military spending.

## Sixth Nuclear Rocket Fired

Project *Rover*, the nation's nuclear rocket development program, apparently took another step forward Nov. 30 with the sixth stationary test of an experimental nuclear reactor—the Kiwi B-4A.

The test run at Jackass Flats, Nev., proceeded with liquid hydrogen for some 260 sec. Shutdown of the reactor was ordered before planned power was reached, but the AEC said an initial look at recorded data showed normal reactor operation.

## Tiros To Test Photo System

Development of an inexpensive photo transmission system that will permit ground stations around the world to receive local cloud cover pictures from orbiting satellites has been announced by the space agency.

The Automatic Picture Transmission subsystem (APT) will require relatively simple ground station equipment costing only $30,000.

Although designed for the *Nimbus* weather satellite, the system will be flight-tested on a *Tiros* satellite in mid-1963.


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***Blue Gemini tie-up possible . . .***

# SAINT Reoriented for Future

***Military insists Air Force program will be continued regardless; RCA contract only partially cut—others unaffected***

REORIENTATION of the lagging *Satellite Inspector* program (621A) may be linked to still-unannounced approval of a four-to-five-capsule *Blue Gemini* program for the Air Force, industry sources said last week.

Reprograming of affected Fiscal Year 1963 funds could get *Blue Gemini* under way early next year. Technical observers noted the strong similarity of rendezvous technology of the two programs.

Military sources say, however, that continuation of the *SAINT* program is not contingent on approval of *Blue Gemini*. "This is not an either/or proposition," one said. "Work definitely will continue on an advanced *Satellite Inspector*."

The SSD program office responsible for the advanced system already has received a designation, Program 706. Emphasis has been shifted from vehicles to sensors.

One fact was clear following official confirmation of the *Satellite Inspector* reorientation: it may have saved the system from cancellation by Dept. of Defense by pointing it toward a more advanced system.

Significantly, when the announcement of the reorientation was made public last week, it was stressed that the contract with the Defense Electronics Div. of RCA would be only partially terminated. Specifically, the fabrication and assembly of *SAINT* vehicles would be reduced and the flight demonstration phase would be eliminated. Hughes Aircraft Co., which holds a contract from the AF Special Weapons Center at Kirtland AFB, N.M., for the development of the sensor payload, was not affected by the reorientation; neither, reportedly, was Aerojet-General, which was developing a multiple-re-start storable liquid propellant motor.

• **Where from here?**—One industry observer commenting on the reorientation pointed out that when *SAINT* was originally conceived the idea of employing a manned vehicle for space rendezvous was not even being considered seriously. Since that time, he points out, NASA's *Gemini* has come into being and the Air Force is attempting to get approval of the *Blue Gemini* —a system ideally suited to fulfill many rendezvous requirements. There is strong industry belief that AF's next step will be to a manned interceptor-type vehicle.

Another apparently major concern was that technology was so far beyond that originally envisioned in the *SAINT* program that the vehicle would be obsolete before it became operational. Thus, according to informed sources, one of the first steps in the reorientation will be to fix the technology now available —at the same time thoroughly re-evaluating the threat in the time-period of an operational *Satellite Inspector*.

A recent speech by Col. Joseph S. Bleymaier is considered significant in that he pointed out that the transtage of the *Titan III* "means a real bonus for payload designers." Specifically, Bleymaier said, "this (the transtage) assumes even greater significance in light of the Air Force's anticipated space maneuver requirement, necessary for the inspection of and rendezvous with other vehicles in space—particularly those capable of evasive action."

• **Program history**—Originally conceived to demonstrate military rendezvous with unknown or unidentified space objects in Earth orbit, *SAINT* was initiated in 1960. Initial launches of the space vehicle were to have been made in 1962 by an *Atlas-Agena B*.

Program funding was never adequate, according to informed sources. Some $6.1 million was budgeted in FY '61, $10 million in FY '62 and $40 million in FY '63. The latter funds apparently were never released, and approximately $3 million from FY '62 monies are being used to terminate the RCA contract.

Other contractors on the program were: Minneapolis-Honeywell, guidance; Avco, structures and interstage: Emerson Electric and Westinghouse, radar equipment; Douglas, spacecraft fairing; Applied Design Co., ground handling and erection trailers and Garrett Corp., temperature control unit. ⁂

## Economies May Cause Mariner Failure

EXTREME ECONOMY measures are blamed for the possibility that *Mariner II* may not accomplish its planetary exploration mission when it passes Venus on Friday, Dec. 14.

Industry sources report that the excessive temperatures recorded on board the spacecraft resulted from inadequate heat control measures forced by shortage of time and money.

JPL scientists were allowed funds to build only three spacecraft and were ordered to deliver them to Cape Canaveral only 9½ months after the program was approved.

Two of the spacecraft were flight models and the other was designated a backup. Thus, JPL had no opportunity to define limits by testing a spacecraft to destruction.

Component temperatures have averaged 30° higher than anticipated.

This is still within the margin allowed by the designers, but temperatures are rising faster than expected and component acceptance tests lasted only about 12 days—far less than the actual interplanetary exposure time. Three components will reach or exceed their acceptance test temperatures by the time of Venus encounter. Comparison of test limits and actual temperatures recorded on the spacecraft for the components shows:

—Earth sensor acceptance test limit: 130°F; at Venus encounter: 169°F-165°F.

—Battery acceptance test limit: 120°F; at Venus encounter: 129°F.

—Solar cell acceptance test limit: about 250°F; at Venus encounter: about 250°F.

Whether or not its exploration of Venus succeeds, *Mariner II* is already being recognized as the most rewarding space probe since *Explorer I* discovered the Van Allen Belt. It is sending a wealth of design data and information on interplanetary magnetic field, micrometeorite density, etc., from deeper in space than any previous vehicle.

***Selection next spring . . .***

# RFP's for DOD's ComSat Due Soon

## *Ground environment, spacecraft requests also at hand; Defense Communications Agency reorganized to handle operation*

**by James Trainor**

REQUESTS for proposals for the Dept. of Defense medium-altitude communication satellite system are expected to be issued to industry before the end of this month.

At almost the same time, RFP's for the ground environment will be issued by the U.S. Army Satellite Communications Agency, Ft. Monmouth, N.J. Spacecraft RFP's will be issued by the Air Force Space Systems Division, Inglewood, Calif.

Defense Communications Agency—responsible for the interface problems of DOD communications satellites—was established in 1960 as a single manager for all Dept. of Defense long-haul, point-to-point Government-owned and leased communications. It will also be the operating agency for the communications satellites established.

Since interested companies are already well aware of Defense requirements for the medium-altitude system and are already primed for the RFP's, DCA officials estimate that a minimum of 30 days will be allowed for industry to submit proposals. The Army and Air Force will require at least another month for evaluation of proposals before forwarding recommendations on source selection to the Defense Director of Research and Engineering.

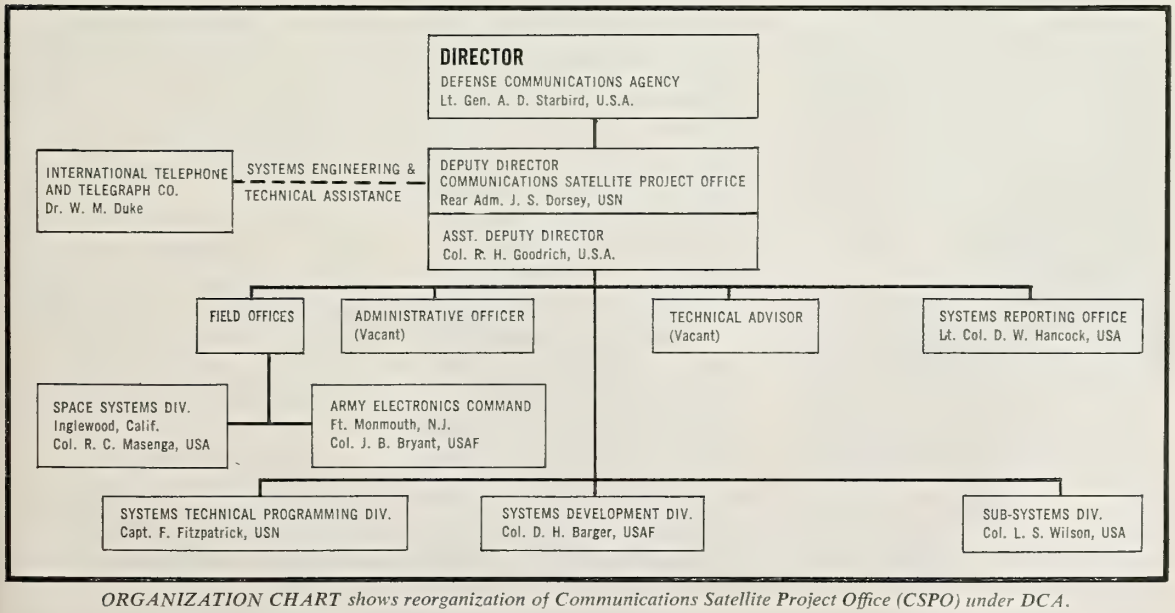
A final selection of at least two contractors—one for the spacecraft and one for the surface environment—is expected to be announced by the Defense Department by early spring. However, DCA officials expect that a program definition phase will be conducted, where required. Therefore, some of the final awards may not be made until June.

Work on the synchronous-altitude communications satellite system will not be emphasized until after contracts on the lower-altitude system have been awarded. "This is based on the fact that the technology is more available for the medium-altitude satellite system as defined than for the synchronous orbiting concepts that will meet military needs," DCA officials point out.

• **Medium-altitude system**—One of the main purposes of the RFP's will be to determine how sophisticated, in terms of encryption, anti-jamming and traffic capacity, the medium-altitude system can be. Criticism of a low-altitude system had been voiced by the House Science and Astronautics Committee in its Nov. 1 report on the *Advent* program because it would not include "many of the desirable features of an ideal military communications system."

An estimated 24 to 36 satellites will be required in 5000-12,000 n. m. random orbits to achieve world-wide coverage and continuous communication. Each satellite is expected to weigh approximately 100 lbs. and carry active repeater equipment for narrow band-width voice and teletype communications.

Launched into polar orbit by the *Atlas-Agena*, the medium-altitude satellites will be separated in space by mechanical means (such as springs) when they are in the appropriate position. Each *Agena* payload will consist of at least five satellites. The multiple-launch




*ORGANIZATION CHART shows reorganization of Communications Satellite Project Office (CSPO) under DCA.*

technique, according to DCA officials, presents no problem to achieving an operational system.

The surface environment is expected to be compatible with both the medium- and high-altitude systems and provide both fixed and mobile stations for military commanders on land and aboard ship. The main difficulty in the ground system for the medium-altitude ComSat—and the most serious objection raised by the House committee—is the requirement for a "highly complex and expensive" aggregation of ground equipment for acquiring, switching and communicating with the lower-altitude system. Development of a ground environment that can be used with both satellite systems probably will assuage Congressional feelings while at the same time reducing the overall development costs of the two ComSats.

Early estimates of the cost to develop the medium-altitude system have been between $100-$140 million.

• **DCA reorganized**—To handle its expanded responsibilities, the Defense Communications Agency has been completely reorganized. Effective Nov. 26, the new organization includes a two-star Deputy Director for the Communications Satellite Project Office (CSPO), Deputy Director for the National Military Command System (NMCS) and Deputy Director for the Defense Communications System (DCS).

Rear Adm. Jack S. Dorsey will head CSPO and will report to the newly-installed Director of DCA, Lt. Gen. Alfred D. Starbird. Originally, Rear Adm. Frank Virden had been named to fill the CSPO slot, but he was later retained as Commander of the Pacific Fleet's Cruiser-Destroyer Force.

In addition to communications assignments at the Navy's Postgraduate school at Monterey, Calif., and on the Joint Staff of the Caribbean Command, Adm. Dorsey has headed the Shore Branch, Naval Communications Division and was Assistant Director, Naval Communications. In 1958, he became Deputy Director for Communications-Electronics, JCS, before being transferred in 1960 to the command of a destroyer flotilla.

Dorsey's Assistant Deputy Director is Col. Raymond H. Goodrich, USA, who came to DCA from Ft. Monmouth. Reporting to Adm. Dorsey will be four staff elements and two field offices: a Systems Reporting office, a Systems Technical Programing Div., a Systems Development Div., a Sub-systems Div. and two field offices, one at SSD in Inglewood, Calif., and the other at Ft. Monmouth.

The organization is presently in the process of building up to full strength of about 40. This buildup, now approximately 50% complete, is expected to achieve its goal by January.

• **DCA authority real**—One of the major Congressional criticisms of the *Advent* management structure was the lack of "a strong single manager at the Department of Defense level." Under the reoriented program, DCA has been established as the "strong focal point" within DOD. In certain areas, DCA officials say, the agency has the authority to rule, although the military services can appeal to OSD through the service secretaries for reconsideration.

The real program manager, DCA officials feel, is the Director, Defense Research and Engineering. Certain very real powers—particularly in the areas involving compatibility of interfaces—are delegated to DCA Director Starbird. In other words, these officials say, functional supervision of the program will be carried out by DDR&E, with Starbird acting as its executive agent.

The reorganization and expansion of DCA marks the beginning of Phase II in the Agency's development. Initially, the organization was created May 12, 1960, to tie together all the global military communications systems. It did not have a large staff and was given a very small research and development budget. However, with the assignment of the National Military Command System and the Communications Satellite programs, DCA has matured and, in the future, will be able to develop its own communications systems.

• **ITT's role in ComSats**—Although DCA utilizes program management principles of the Army and Air Force, the role of International Telephone and Telegraph in the Agency's setup differs somewhat from that played in Air Force programs by companies such as Aerospace Corp. and Mitre Corp. ITT's charter includes systems engineering and technical assistance—the key word being assistance rather than technical direction.

To assist DCA in performing its mission, ITT has set up a subsidiary—ITT INTELCOM, Inc. located at 5817 Columbia Pike, Bailey's Crossroads, Va.—to implement this contract. ⁂

## NASA Stalls Army Lunar Base Role

NASA HAS BLUNTED for the moment an Army Corps of Engineer's drive for a major role in the space agency's lunar base program.

The Corps had proposed to the space agency that it be given responsibility for construction of a lunar base, and that an immediate start be made in required research. Included was the plan for a multimillion-dollar lunar base simulator.

NASA has informed Army officials that the proposal is "premature." Instead, it has awarded the Corps a $100,000 study contract to define the research effort needed to give the U.S. a lunar construction capability.

The space agency rejection stemmed from the belief that it is too early to establish a requirement for a lunar base or the research effort leading to its development.

The current timetable calls for the lunar base to follow the first manned lunar landing missions. This would push its development to 1969 or the early 1970's. It is estimated that actual hardware contracts are at least three years away.

NASA officials also "strongly suspect" that the lunar base research program will not require any new simulator. They believe that current space agency and DOD simulator facilities will be sufficient.

NASA officials do not rule out the possibility that the Engineers will eventually get the lunar base responsibility they seek. They note, however, that this will be sometime in the future.

• **Study plans**—Once the current six-month contract is completed, it is expected that further studies will be made by the Corps, NASA and industrial firms.

Objectives of the Army study are to define the needed research and development effort, establish requirements for experimental facilities on Earth, and prepare schedules and budgetary estimates for the lunar construction research program.

The new study will take into account results of related earlier studies by the Air Force and Army (Project Horizon).

Areas of research to be considered will include lunar soil characteristics, lunar solid movement and excavation techniques, construction materials, structural design, power generation, storing and handling of life-supporting atmosphere, water supply and sanitation, construction tools and human engineering and training.

The Corps of Engineers will assign approximately 10 people to the study, which will be performed at the Corps' Gravelly Point Headquarters in Washington, D.C., under the direction of the Office of Manned Space Flight.

# SNAP-50 Details Revealed at CANEL

***Lightweight 1-mw unit to fly by 1970; lithium and columbium technology inherited from ANP work***

by Frank G. McGuire

MIDDLETOWN, CONN.—The high-power *SNAP-50* reactor system is expected to be flight-tested by 1970 and probably will be used for unmanned missions during the first years of its operating service, later being incorporated into large manned vehicles.

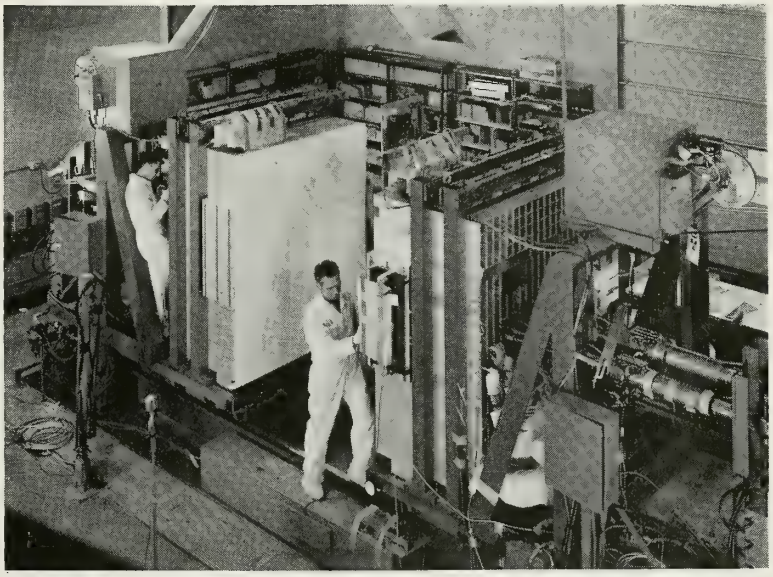
Details of the one-megawatt-potential system emerged here as the Atomic Energy Commission unveiled its Connecticut Advanced Nuclear Engineering Laboratory and described some of the technological "fallout" from the cancelled aircraft nuclear propulsion (ANP) program.

CANEL, operated for AEC by Pratt & Whitney Aircraft, is devoting its entire effort to *SNAP-50* and the accompanying lithium, columbium and reactor technologies. The $64-million government-owned facility is considered a prime center of columbium technology because of its ANP work, and the metal has been under development for the plumbing of *SNAP-50's* conversion system.

The system's lithium-cooled reactor generates heat that is carried by liquid lithium at 2000°F to a heat exchanger, where liquid potassium is boiled to a vapor used to drive a turbine for operating an alternator to generate power. The potassium vapor is then carried to another heat exchanger, where it is condensed into liquid, the waste heat being carried into space through a radiator system. The liquid potassium is pumped to a secondary radiator, where its temperature is lowered further, before being used as a coolant for the alternator and other components.

Walter Doll, P&W's general manager at CANEL, said the firm expects to operate a lithium-cooled reactor experiment (LCRE) at AEC's reactor test facility in Idaho sometime in early 1965. This experiment, which will use no power conversion equipment, is aimed at testing the reactor and primary lithium loop, using a heat dump converted from the ANP program.

Ducting for the final *SNAP-50* system, all under 4-in.-dia., is of columbium-zirconium alloy and will operate at about 2000°F, providing high strength and reliable lithium containment. Other than the metals technology, ANP also contributed high-temperature liquid metal pumps, heat exchangers, and reactor fuel elements, controls and pressure vessels.



*REACTOR TABLE at CANEL is divided into halves of grid structure, for testing core designs. Grids loaded with fuel elements move together to begin reaction.*

Using a uranium dioxide and beryllium fuel, the LCRE will first concentrate on space powerplant design studies, materials and fuels development, and component design and engineering—with a view toward realizing the 10,000-hour operating lifetime set for *SNAP-50*.

One major component of the complete system for which P&W is not directly responsible is the radiator. This design, which must fit into a *Titan III* nose cone, has not yet been established; it probably will grow out of radiator research now going on at a number of installations.

• **Subcontracting to swell**—The direct AEC facility supporting P&W in the *SNAP-50* program is Oak Ridge National Laboratory. Argonne National Laboratory is responsible for in-house exploratory research and analysis leading to higher temperature and high power levels.

Forced by the ANP cancellation to pull much of its subcontracting back into its own shops, P&W says about one-third of the *SNAP-50* work is now subcontracted, and that this figure will rise as the program progresses.

Funding for the program moved from $16 million in FY '62 to $25 million in FY '63, and probably will increase again this year. The program is currently in the hands of the Budget Bureau.

• **CANEL**—The Connecticut Advanced Nuclear Engineering Laboratory, built in 1955-57 with Air Force money, was originally constructed for the ANP program, which was cancelled in March, 1961.

CANEL occupies 1100 acres on the west bank of the Connecticut River about five miles south of Middletown. P&W employees total 1600, and AEC has 14.

The 25 buildings at the facility total over 725,000 sq. ft. and include: laboratories for nuclear fission experiments; cells for dissecting and examining radioactive materials; equipment for developing and testing refractory metals and alloys, including liquid metals; clean rooms for critical assembly and machining; laboratories for developing liquid-metal pumps; and machine shops. ⁂

# Lockheed Heads Defense Contractors

LOCKHEED AIRCRAFT Corp. jumped from third to first place on DOD's list of the 100 top prime contractors for Fiscal Year 1962. The Lockheed move displaced General Dynamics from the top spot for only the second time in six years.

Other shuffling in the top 10 companies—four of which did more than a billion dollars worth of business with the Defense Department during FY '62—saw North American Aviation, Inc. drop from second place to fourth and Boeing Co. move up one place to third. The only other change in the top 10 was the displacement of Hughes Aircraft Co. (down to 23rd place) by General Motors Corp., which jumped into the top 10 from its FY '61 position of 19th.

Significantly, the 100 companies accounted for some 72.3% of the U.S. total—a decline of 1.9% from the 74.2% during FY '61 and the lowest percentage obtained by the 100 top companies in the last five years. This was attributed to the aggressive Small Business program under way in DOD. Small business concerns accounted for 17.7% of DOD business versus 15.9% in FY '61.

Total DOD contracts amounted to $25,588,400,000, with the 100 top firms accounting for $18,497,200,000. ⠿

## DOD LIST OF FY '62 100 TOP PRIME CONTRACTORS

| FY '62 Rank | '61 Rank | Company | FY '62 Contracts (in Millions of Dollars) | FY '61 Contracts (in Millions of Dollars) |
|---|---|---|---|---|
| 1 | 3 | Lockheed Aircraft Corp. | 1,419.5 | 1,175.2 |
| 2 | 1 | General Dynamics Corp. | 1,196.6 | 1,460.5 |
| 3 | 4 | Boeing Co. | 1,132.8 | 919.8 |
| 4 | 2 | North American Aviation, Inc. | 1,032.5 | 1,197.4 |
| 5 | 5 | General Electric Co. | 975.9 | 874.6 |
| 6 | 6 | Martin Marietta Corp. | 802.7 | 691.8 |
| 7 | 7 | United Aircraft Corp. | 662.7 | 625.5 |
| 8 | 8 | American Telephone & Telegraph Co. | 467.7 | 550.6 |
| 9 | 9 | Sperry Rand Corp. | 465.6 | 408.0 |
| 10 | 19 | General Motors Corp. | 449.0 | 281.8 |
| 11 | 15 | Raytheon Co. | 406.6 | 304.9 |
| 12 | 17 | General Tire & Rubber Co. | 344.1 | 290.2 |
| 13 | 14 | Douglas Aircraft Co. | 365.6 | 307.4 |
| 14 | 10 | Radio Corp. of America | 339.6 | 392.3 |
| 15 | 16 | Republic Aviation Corp. | 332.8 | 295.7 |
| 16 | 21 | AVCO Corp. | 323.3 | 251.6 |
| 17 | 23 | McDonnell Aircraft Corp. | 310.9 | 219.9 |
| 18 | 22 | Grumman Aircraft Engineering Corp. | 303.6 | 238.0 |
| 19 | 20 | Bendix Corp. | 265.9 | 266.8 |
| 20 | 43 | Ford Motor Co. | 269.1 | 81.0 |
| 21 | 13 | Westinghouse Electric Corp. | 246.0 | 307.7 |
| 22 | 25 | International Telephone & Telegraph Corp. | 243.6 | 201.6 |
| 23 | 11 | Hughes Aircraft Co. | 234.2 | 331.2 |
| 24 | 30 | American Machine & Foundry Co. | 187.3 | 119.8 |
| 25 | 18 | Newport News Shipbuilding & Dry Dock Co. | 185.0 | 290.2 |
| 26 | 32 | Hercules Powder Co. | 181.6 | 117.0 |
| 27 | 27 | Chrysler Corp. | 181.5 | 158.2 |
| 28 | 26 | Standard Oil Co. (New Jersey) | 180.1 | 167.7 |
| 29 | 24 | Thiokol Chemical Corp. | 178.3 | 210.0 |
| 30 | 38 | FMC Corp. | 160.4 | 87.9 |
| 31 | 12 | International Business Machines Corp. | 155.5 | 330.0 |
| 32 | 28 | Northrop Corp. | 152.5 | 155.6 |
| 33 | 37 | Collins Radio | 150.1 | 94.0 |
| 34 | 29 | Pan American World Airways, Inc. | 146.7 | 127.4 |
| 35 | 47 | Curtiss-Wright Corp. | 144.6 | 69.8 |
| 36 | ... | Kiewit (Peter) Sons' Co. | 142.7 | ..... |
| 37 | 61 | Ling-Temco-Vought, Inc. | 133.4 | 46.8 |
| 38 | 40 | Minneapolis-Honeywell Regulator Co. | 127.5 | 85.5 |
| 39 | 50 | Textron, Inc. | 117.4 | 65.8 |
| 40 | 55 | General Telephone & Electronics Corp. | 116.3 | 61.4 |
| 41 | 34 | Standard Oil Company of California | 115.2 | 109.4 |
| 42 | 39 | Texaco, Inc. | 108.0 | 85.5 |
| 43 | 45 | Thompson-Ramo-Wooldridge, Inc. | 105.7 | 76.9 |
| 44 | 44 | Bethlehem Steel Corp. | 99.9 | 79.4 |
| 45 | ... | Litton Industries, Inc. | 88.3 | ..... |
| 46 | 89 | White Motor Co. | 87.4 | 28.7 |
| 47 | .... | Kaiser Industries Corp. | 87.1 | ..... |
| 48 | 33 | Burroughs Corp. | 86.8 | 111.5 |
| 49 | 49 | Continental Motors Corp. | 86.6 | 68.4 |
| 50 | 68 | Kaman Aircraft Corp. | 83.8 | 40.2 |
| 51 | 53 | Goodyear Tire & Rubber Co. | 83.2 | 62.6 |
| 52 | 41 | Massachusetts Institute of Technology | 82.1 | 82.5 |
| 53 | 35 | American Bosch Arma Corp. | 81.4 | 107.6 |
| 54 | 51 | International Harvester Co. | 80.8 | 63.1 |
| 55 | 79 | Magnavox Co. | 73.2 | 32.4 |
| 56 | 60 | Lear-Siegler, Inc. | 73.1 | 50.2 |
| 57 | 42 | General Precision Equipment Corp. | 70.5 | 81.3 |
| 58 | 57 | Shell Caribbean Petroleum Co. | 67.4 | 56.9 |
| 59 | 58 | Socony Mobil Oil Co. | 65.8 | 52.9 |
| 60 | 75 | Aerospace Corp. | 63.4 | 34.8 |
| 61 | 62 | Morrison-Knudsen & Associates | 61.0 | 45.6 |
| 62 | ... | Bowen-McLaughlin-York, Inc. | 59.0 | ..... |
| 63 | 70 | Eastman Kodak Co. | 55.4 | 38.3 |
| 64 | 59 | Olin Mathieson Chemical Corp. | 53.3 | 52.5 |
| 65 | 46 | Bath Iron Works Corp. | 51.2 | 73.1 |
| 66 | ..... | Hayes International Corp. | 51.0 | ..... |
| 67 | 56 | Garrett Corp. | 46.7 | 59.9 |
| 68 | 73 | Mason & Hanger—Silas Mason Co. | 44.3 | 36.5 |
| 69 | 78 | Continental Oil Co. | 44.2 | 33.7 |
| 70 | 63 | Johns Hopkins University | 44.0 | 44.6 |
| 71 | 66 | DuPont (E. I.) De Nemours & Co. | 42.2 | 41.1 |
| 72 | ... | Hardeman-Fischback | 40.9 | ..... |
| 73 | 67 | Todd Shipyards Corp. | 40.4 | 40.6 |
| 74 | 85 | Laboratory for Electronics, Inc. | 40.3 | 29.7 |
| 75 | ..... | Kaiser-Raymond-Macco-Puget Sound | 39.7 | ..... |
| 76 | .. | Flying Tiger Line, Inc. | 39.1 | ..... |
| 77 | 98 | Marquardt Corp. | 38.8 | 26.3 |
| 78 | ... | Harrington & Richardson, Inc. | 38.5 | ..... |
| 79 | 76 | Richfield Oil Corp. | 38.4 | 34.3 |
| 80 | 81 | Standard Oil Co. (Indiana) | 36.8 | 31.6 |
| 81 | 87 | Hazeltine Corp. | 36.0 | 29.5 |
| 82 | ... | Cities Service Co. | 35.8 | ..... |
| 83 | 72 | System Development Corp. | 35.1 | 36.7 |
| 84 | 90 | Vitro Corp. of America | 35.0 | 28.4 |
| 85 | 69 | Fairchild Stratos Corp. | 35.0 | 39.8 |
| 86 | 100 | Motorola, Inc. | 33.5 | 25.6 |
| 87 | 65 | Ryan Aeronautical Co. | 33.4 | 42.0 |
| 88 | .... | Motec Industries, Inc. | 33.1 | ..... |
| 89 | 97 | Aro, Inc. | 32.8 | 26.4 |
| 90 | 52 | Sanders Associates, Inc. | 32.1 | 63.1 |
| 91 | ..... | Phillips Petroleum Co. | 32.0 | ..... |
| 92 | 94 | Universal American Corp. | 31.9 | 27.9 |
| 93 | ... | Mitre Corp. | 30.2 | ..... |
| 94 | ... | Ogden Corp. | 30.2 | ..... |
| 95 | . | Harvey Aluminum, Inc. | 29.0 | ..... |
| 96 | 99 | Texas Instruments, Inc. | 29.0 | 26.2 |
| 97 | | Gilfillan Corp. | 28.9 | ..... |
| 98 | .. | Blount Brothers Construction Co. | 28.8 | ..... |
| 99 | 48 | Hallicrafters Co. | 28.7 | 68.9 |
| 100 | .. | Union Carbide Corp. | 27.2 | ..... |

# Probe of SNAP Program Under Way

***AEC report, due in summer of '63, expected to establish guidelines for developing advanced nuclear power units***

**by William Beller**

THE ATOMIC ENERGY COMMISSION is taking a new and hard look at the entire *SNAP* program. Reasons are twofold: anticipation of rapid growth in the nuclear space effort, and reaction to complaints of sluggishness in developing space nuclear power.

When the probe was announced late last month, AEC chairman Dr. Glenn T. Seaborg pointed out that AEC's expenditures with industry for the nuclear space program will exceed $200 million during the current fiscal year.

He indicated this amount would be minimum funding because "as the ROVER concept and the *SNAP* concepts progress through their various stages of development, further growth and further expenditures must be anticipated."

The investigation of *SNAP*—intended to be comparable to a recently completed extensive AEC study of civilian nuclear power—is expected to be finished in mid-summer 1963. An in-house effort, it will lay the guidelines for AEC's development of advanced nuclear power units. For this reason, the AEC is extremely eager to enlist the aid of all interested government agencies.

Once the *SNAP* report is finished, industry is expected to be able to orient nuclear R&D work more easily along the lines of AEC thinking.

Seaborg said he expects the power level of nuclear space units to reach one megawatt by the mid-1970's; and to reach beyond one megawatt—with thermionic systems—by the late 1970s.

• **A helping hand**—The AEC chairman recognizes the business risks involved in programs as costly and complex as developing nuclear power. He recently said that when engineering is pushed to the edge of present capability, a company—indeed, an entire industry—could reach a point where the investment is almost too great to turn back, and the uncertainties are almost too great to justify further capital commitment.

Such a problem presents corporate management with a grave choice—one that challenges its confidence and convictions as well as its capital. "It is my personal view that in such dilemmas the Government has a responsibility," Seaborg said.

The chairman did not amplify this remark. Insiders took it to mean that if a company is on the brink of a significant contribution to the nuclear space program, but is running out of funds, it would be poor economy for the Government not to help bail the company out in terms of contracts or other means.

• **The SNAP probe** — The *SNAP* study is expected to go along the following lines:

—The state-of-the-art will be drawn and opportunities for future developments outlined.

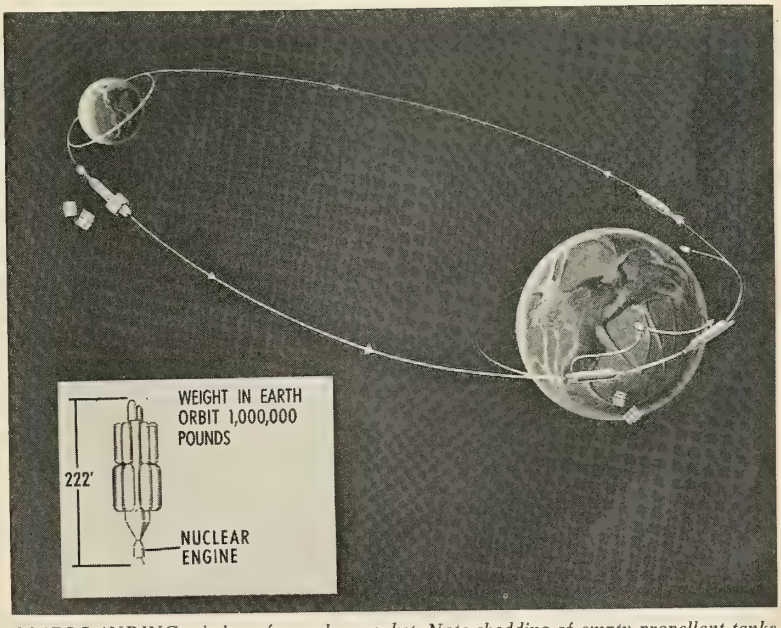
—The firm requirements of the chief using agencies—NASA and Defense—will possibly be determined for the *SNAP* units, including estimates of the power levels needed.

—The fuel requirements for the radioisotope *SNAP* units will be determined. If it looks like fuel will be short, suitable provisions for a production program will be recommended.

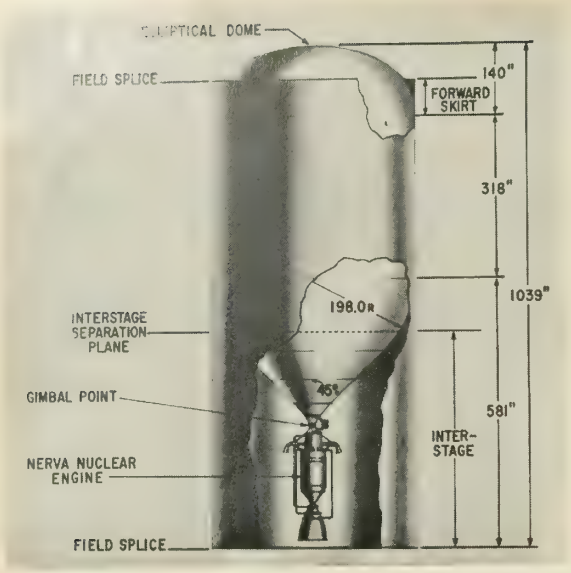
—The expected costs of the various *SNAP* units will be compared with the costs of other means of generating power for space missions.

The AEC expects the study to include terrestrial application of *SNAP* devices. "We would welcome, at this stage, the suggestions and comments of the nuclear space industry," said Seaborg, "particularly with respect to the scope and method of the study."

Explaining the study further, Seaborg told MISSILES AND ROCKETS, "It's more a look to the future than a look backward." He explained, "We get inquiries about power units: one agency wants a 25-watt unit and another a 50-watt. We




*MARS LANDING mission of a nuclear rocket. Note shedding of empty propellant tanks.*




*DIMENSIONS of RIFT (reactor in-flight test) stage of nuclear rocket system. Dry structure wt., 44,000 lbs.; total wt., 200,000 lbs.; propellant capacity, 156,000 lbs.; stage dia., 396 in.*

can't develop them all. What we don't want is a proliferation of *SNAP* units."

Asked whether he had in mind merging or eliminating any of the *SNAP* units already under development, Seaborg said "This is not our purpose, nor do we have any particular units in mind." He added, "It all depends on our study—if it shows we should take such actions."

• **Hard-to-get requirements**—Seaborg recognizes he may have problems getting firm requirements from NASA and DOD for advanced and high-power *SNAP* units. It took a congressional hearing for the AEC to be assigned full responsibility for developing the nominal 300-kw *SNAP* unit (M/R, Sept. 24, p. 14). Even so, neither NASA nor DOD would commit itself to requirements.

Looking optimistically to the future, Seaborg said, "We will try to persuade the agencies to cooperate with us so we can plan better and help them. We have the responsibility to develop devices which we see will be useful and that some agency will want in the future." He said that the AEC expects to work with NASA on analyses of space missions for *SNAP* purposes.

Repeated criticisms of the seeming confusion in space nuclear power reached congressional proportions this past summer when Rep. Melvin Price (D-Ill.) said, "AEC, NASA and DOD still cannot agree on how to manage and coordinate the required *(SNAP)* research and development program." He added, "This program is too vital to tolerate unnecessary delays."

One result of this criticism—and of the September hearings of the Joint Committee on Atomic Energy—is believed to be the newly instituted AEC study of the *SNAP* program.

Industry criticism of AEC's lagging nucelar space-power program was evident at the joint Atomic Industrial Forum and American Nuclear Society meeting in Washington last month (M/R, Dec. 3, p. 13).

Jerome G. Morse, director of Martin Marietta Corp.'s auxiliary power systems department, reportedly complained there are no nuclear space-power systems now under specific development for communications satellites, and consequently other nuclear power systems must be adapted for such use.

Similarly, R. P. Haviland of General Electric noted, "One of the major differences between (G. E.'s) estimates and the current nuclear space-power technology lies in the design lifetime." He said that in general, "These estimates indicated that the lifetime must be appreciably greater than is contemplated by existing programs."

The AEC expects to use such criticisms as inputs to its current *SNAP* study.

• **Business opportunities** — Many hundreds of millions of dollars presumably are to be spent in developing nuclear power for space—for auxiliary power as well as propulsion. Yet because of the large magnitude and severe requirements of each of the programs, the number of procurements at a prime contract level is relatively small.

More encouraging from a business viewpoint is the number of subcontractors. As of Oct. 15, there were 12 corporate-type contractors and 2350 vendors in the *SNAP-2, 8* and *10A* programs.

The attrition rate gives a more sobering picture. Seaborg pointed out that at one time there were 21 companies in the uranium-fuel fabrication business; 17 remain. There were 25 companies in the reactor manufacturing business; 20 remain. A few of the companies still in the atomic energy business reportedly are finding it difficult to continue participation in the present market. Still other companies invested fairly substantial amounts to get into the nuclear business, only to find it necessary to withdraw before they were really in it.

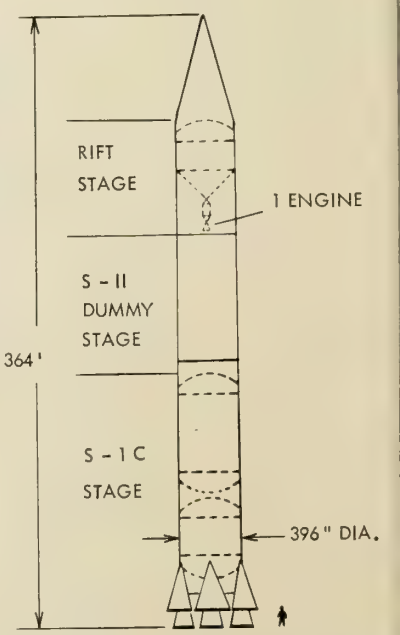
In this view, "I think it is a happy commentary that so few companies have withdrawn from the nuclear business, and of course some of the withdrawals have been for purposes of consolidation." Nevertheless, Seaborg said, "These statistics contain a message for those who are contemplating entering this exciting but expensive field."

• **Nuclear power uses**—A development area that has received very little attention is the use of nuclear power supplies for facilities on other planets.

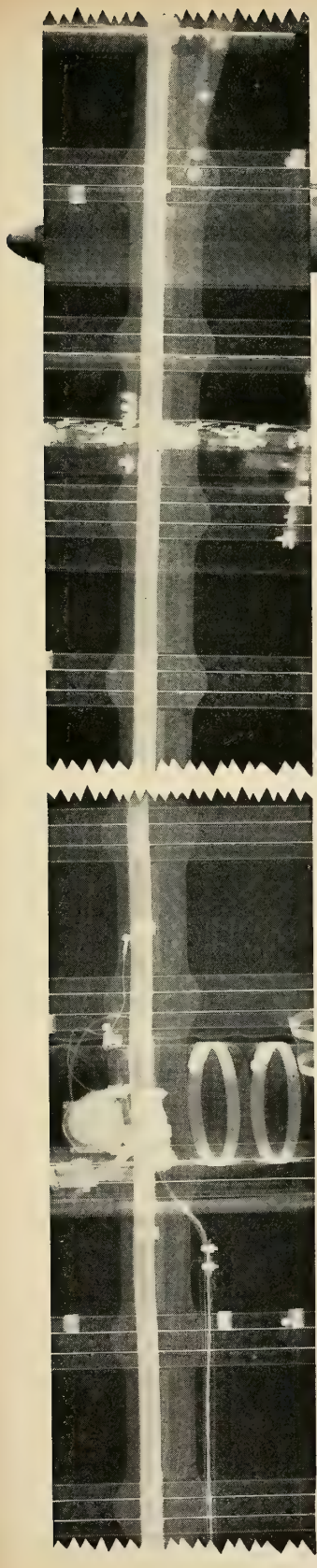
Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, in suggesting this use said, "Truly effective nuclear interplanetary transport . . . will require special power stations, light in weight but able to supply the needs of expanding bases on other planets."

Last week the Army Corps of Engineers received the go-ahead from NASA to look into the problems of setting up a lunar base, and accordingly the problems of recommending an adequate power supply; this conceivably would be nuclear power.

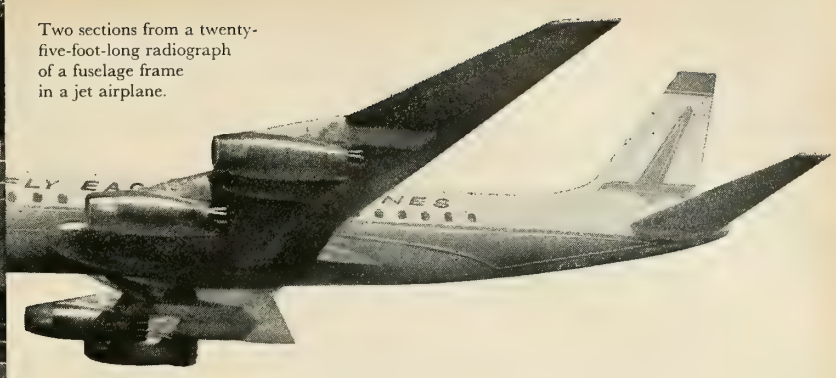
Considering the long lead times in most nuclear developments, Dr. Welsh said it is not too soon to start planning for such equipment now. ■




*RIFT STAGE on Advanced Saturn.*



Two sections from a twenty-five-foot-long radiograph of a fuselage frame in a jet airplane.



# Twenty-five Radiographs become one

## Eastern Air Lines cuts the time and work involved in regular jet airplane fuselage inspection

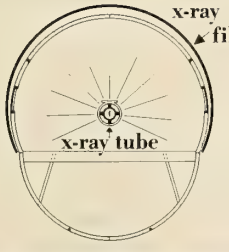
In the past, the regular radiographic inspection of an aircraft fuselage meant girdling each frame section with twenty-five or more separate x-ray films. It meant attaching each individual sheet of film, applying identifying markers and making the exposure.

Now, Eastern radiographs each frame with a single strip of x-ray film.

About twenty-five feet of Ready Pack Type M KODAK Industrial X-ray Film is cut from the roll and wrapped around the fuselage. One x-ray picture is made of the entire frame, on one piece of film, and with one set of identification numbers.

Every day radiography plays a more important part in inspection work. It provides information on internal conditions as nothing else can. It makes a record of its findings for later study. And Kodak, with its staff of technical sales representatives, keeps pace with advancing times and provides x-ray film of the highest quality in forms that facilitate the work of the radiographer.

If you would like to know how radiography can serve you in maintaining product quality, talk to an x-ray dealer or ask us to have a KODAK Technical X-ray Sales Representative call.




Now a single strip of film envelopes the fuselage to radiograph an aircraft's frame.

**Now . . . Ready Pack in Rolls and Sheets, KODAK Industrial X-ray Film, Types AA and M in 200-ft. rolls and sheets in listed sizes.**

- No darkroom loading—film sealed in lighttight envelope.
- Just place Ready Pack in position and expose.
- Film protected from dust, dirt, light, and moisture.
- In the darkroom, remove film from envelope and process.

EASTMAN KODAK COMPANY
X-Ray Sales Division
Rochester 4, N. Y.

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*NOW FROM JOHNS-MANVILLE RESEARCH:*

# THERMOMAT® 383 FELT

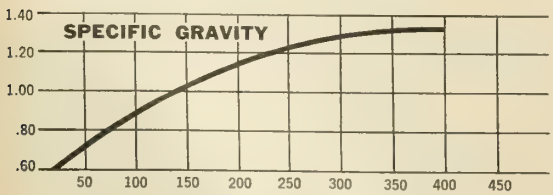
## new low density asbestos-phenolic molding mat for efficient thermal protection of vital missile parts

- **LIGHTWEIGHT**
- **GREATER PROTECTION**
- **LESS BULK**
- **HIGH STRENGTH**

Johns-Manville Thermomat, an asbestos-phenolic molding mat, creates components and parts that withstand tremendous heat and pressure. J-M Thermomat Style 383 was especially developed to provide exceptionally lightweight thermal shielding and the high strength-to-weight ratio so desirable for such low density molded material.

J-M Thermomat Style 383 is composed of an unbonded felt containing 100% ASTM grade AAAA long, randomly dispersed chrysotile asbestos fiber and lightweight fillers, saturated with a phenolic resin, conforming to military specification MIL-R-9299.

Flexible before curing, the partially dried felt is conformable and allows convenient one-man layups. Random fiber dispersion provides uniform, maximum reinforcement to the cured Thermomat. The unique characteristic of the felt allows easy working together of joints and permits free flow of the fiber during the molding operation. Even in intricate configurations, non-fillouts and resin-rich areas are reduced to a minimum. Thermomat's remarkable draping ability saves many man hours of layup time. Molded parts can be easily machined and finished into precision parts with close dimensional tolerances.




Thermomat 383, as delivered in felt form, is ideally applicable to layup and low-pressure vacuum bag molding. However, the versatility of the felt makes it readily adaptable to pressure laminating and match die molding when properly "B" staged.

Based on scientific laboratory tests, Thermomat 383 at 1/3rd the thickness and at 1/9th the weight of standard asbestos-phenolic molded parts has the same thermal shielding effect at 310°F mean temperature.

J-M Thermomat 383 is supplied in uncured felts 14" wide, approximately 12' long and ¼" thick. When stored at temperatures not exceeding 40°F it has a shelf life of at least six months.

Thermomat is also available in other felt styles and in tape form with various properties. See your J-M Representative for further details, or write to Johns-Manville, Box 359, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE THERMOMAT

JOHNS-MANVILLE JM PRODUCTS



Circle No. 10 on Subscriber Service Card

# Technical Countdown

## ELECTRONICS

### First Liquid Laser Tested

Laser action using nitrobenzene as a liquid laser has been achieved by Hughes Research Laboratories. Reported in the current issue of *Physical Review Letters*, the laser operates on a principle known as stimulated "Raman" scattering that had been observed by the Hughes scientists in benzene and six other cyclic-organic liquids. This is believed to be the first involvement of Raman effect in laser action. Since very high pumping energy is required, a high-power short-pulse ruby laser is used as a pumping source. The approach has opened the door to 13 new wavelengths from 7430 to 9630 Angstroms and offers the possibility of whole new classes of wavelengths not previously obtainable with solid or gas lasers.

### Practical Computer Speeds Raised

RCA's new microferrite computer memory system, shown last week at the Fall Joint Computer Conference in Philadelphia, will permit a complete memory cycle in 375 nanoseconds, developers say. This is reportedly the fastest now available commercially (first deliveries will be made this month). The system is capable of handling up to 80 million data bits per sec., but first units will have capacities from 32-1024 words with up to 72 bits/word—or a maximum of 73,728 bits.

### Space Power System Proved Practical

Feasibility of developing a 4-kw photovoltaic-cell electrical power supply for a communications satellite system has been demonstrated analytically for the Air Force by Westinghouse. Such a system, say scientists at the company's Aerospace Electrical Division, would obviate the need for stored fuels, and it uses reliable static converters rather than high-speed rotating devices. Solar-oriented collector panels would be lined with roughly 130,000 cells, each measuring 1x2 cm. System weight is estimated to be comparable to equivalent-output nuclear or solar-turbogenerator systems.

### ARIS Data-Recording Capacity Big

The tracking systems aboard ARIS-1 and ARIS-2, first of possibly 10 to 15 Advanced Range Instrumentation Ships which will extend present missile range capabilities, will record up to 20 million information bits during a 2-minute segment of a missile test firing. The two vessels, converted by Sperry Rand Corp. under an $85-million Air Force contract, are scheduled for operational duty early next year.

### Nearly Frictionless Slip Ring Available

Gyro slip ring friction, long a contributor to gyroscope inaccuracy, has been greatly reduced with a new brush-oscillating assembly developed by the Barden Corp. The just-patented device makes use of the principle of friction cancellation through oscillation of the contacting members. (Slip rings are required to transmit current to the gyroscope spin motor.)

## ADVANCED MATERIALS

### Disappearing Film Proposed for Space Structures

Goodyear Aircraft engineers have perfected a photolyzable film resembling household packaging wrap but with the ability to disappear under the influence of the ultraviolet component in the solar spectrum. The film could be used as a bladder to inflate space structures such as passive ComSats, then would "evaporate" leaving a rigid wire grid. These structures would not be subject to meteoroid penetration problems or large surface changes due to thermal variations. Its use in antennas would eliminate their effect on the heat balance of a space vehicle.

### Heat-Stable Plastics Pushed by Du Pont

A series of heat-stable films, plastic products, finishes and fibers based on aromatic polyimides is moving into production status at three E. I. Du Pont de Nemours & Co. departments—Film, Plastics, and Fabrics & Finishes. The polyimides retain good mechanical and electrical properties over a temperature range from −310° to 650°F, and are among the most fire-resistant organic polymers. One polyimide resin in the family maintained its tensile strength after 1000 hrs. at 572°F. The company says its resistance to chemical degradation by radiation is outstanding for an organic polymer.

### Junk Damage Feared in Titan Silo Launches

Foreign objects—nuts, screws, washers, bits of wire and an occasional tool—behind acoustic liner baskets in some *Titan* silos are causing some concern. Program personnel fear possible damage to a missile during launch if the bits and pieces are stirred up by the high velocity exhaust stream. Liner baskets may have to be removed to clean the areas, a time-consuming and fairly costly undertaking.

### Glass/Phenolic Said to be 30% Stronger

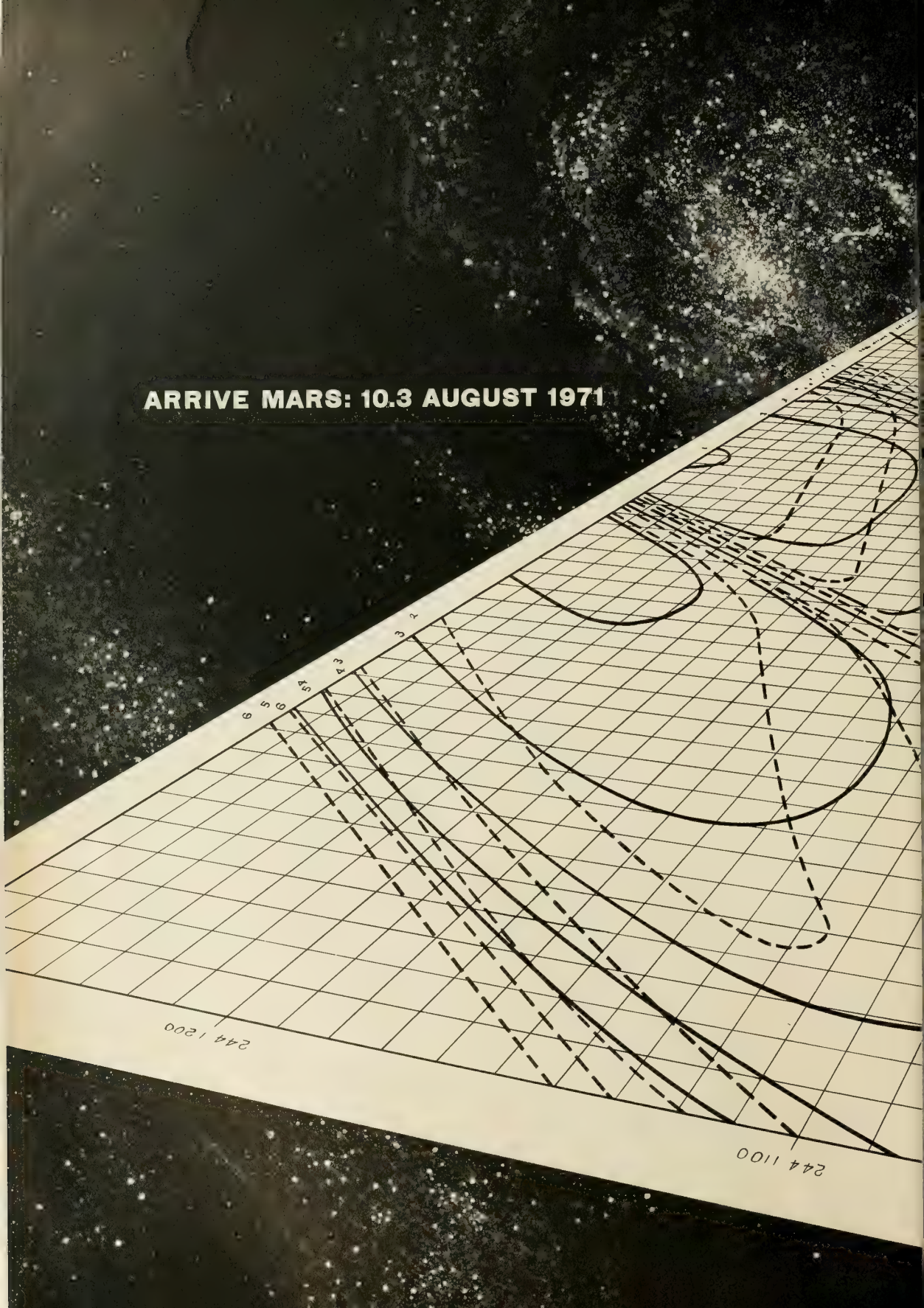
A glass-reinforced phenolic molding compound, Scotchply XP-227—with a flexural strength of 45,000 psi and a tensile strength of 21,000 psi—is out of development at Minnesota Mining & Mfg. Co. The compound has a flexural modulus of 3.67 x $10^6$ psi and an Izod Impact of 27 ft. lbs./in. notch. Composed of random fibers, 3M says the phenolic composite has improved flow and molding characteristics, and may offer cost savings through elimination of layup time. High temperature retention of tensile strength is 38% when exposed to 600°F for 30 min.

### Molybdenum Forging Billets Improved

Close control of melting stock and stepped-up quality control in melting at Climax Molybdenum is resulting in molybdenum ingots of wholly deoxidized workable material with a maximum of 0.005% carbon content. These low carbon contents increase ductility of the moly, which improves forgeability. Forgings made from such material have significantly higher toughness than parts forged from higher carbon content moly.

### New York To Get Test Reactor

With industry backing now firm, officials of the New York State Office of Atomic Development are moving ahead with plans to set up a nuclear test and research facility in the Empire State. (M/R, June 18, p. 36.) The center will house the only advanced pulse reactor in the northeast, and should prove a blessing to electronic firms in the area who presently tote equipment across the U.S. for burst radiation tests. A reactor, probably similar to the one at Oak Ridge, will be built though no contract has been announced and site choice problems still exist.


ARRIVE MARS: 10.3 AUGUST 1971
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Giant steps were taken recently at Lockheed Missiles & Space Company toward manned exploration of the planets Mars and Venus. For the first time, accurate interplanetary transfer orbits have been plotted to show velocities as related to departure and arrival dates for an entire cycle of planet oppositions. A "fast" round-trip would take a year, allowing perhaps ten days exploration time on Mars.

A preliminary but comprehensive study also was made on the spacecraft's design considerations. Many facets were explored—configuration, single versus multi-stages, weight, thrust, payload, exploring, landing, and return equipment; and many more. The arresting conclusion of Lockheed scientists: *A vehicle can perform such a mission within the present state-of-the-art.*

Engineers and scientists at Lockheed Missiles & Space Company conduct many other feasibility and research studies, probing for advanced knowledge in a wide diversity of disciplines. Lockheed's constant expansion, its growing leadership in missiles and space, its ever-widening scope of projects, its ideal location on the beautiful San Francisco Peninsula—all open new and unusual challenges to well-qualified people.

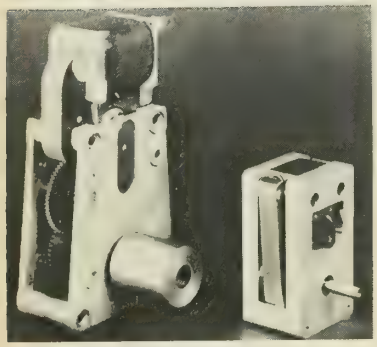
For further information, please write: Research and Development Staff, Department M-25G, 599 North Mathilda Avenue, Sunnyvale, California. Lockheed is an equal opportunity employer.

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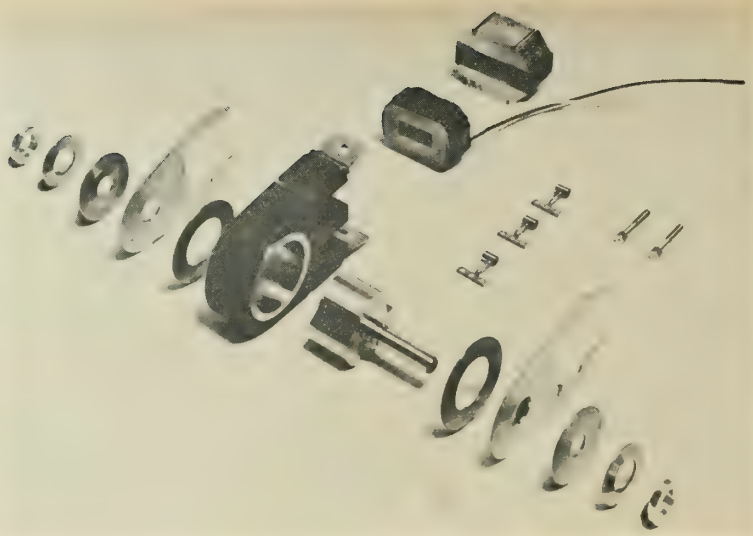
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*PRODUCTION ENERCON unit at right has same output potential as its conventional counterpart at left. Two models weigh 1.25 lbs. and 0.75 lbs., respectively.*



*EARLY EXPERIMENTAL model of Enercon motor had the wedge-roller motion-translation component as an integral part of the output shaft, but without the seating sections cut into the oscillator shown in center.*

# Motor Promises Space Breakthroughs

## *Alternating current device is 80% smaller, 50% lighter than conventional units that employ gear-down techniques*

**by John F. Judge**

A DIRECT-DRIVE, low-speed, rotary-motion electric motor — up to 80% smaller and 50% lighter than conventional units using gear-down devices —is in production at Energy Conversion Systems Corp.

In space applications, the a-c motor will permit substantial weight and size reductions stemming from elimination of the gear train and clutch-brake devices. Further, the system is capable of extremely accurate, repetitive, predetermined motion. Because of the relatively low speed of the few moving parts, little or no lubrication is required.

While the design is applicable to both larger and smaller units, only two motor series of three models each are in initial production. These operate in the fractional horsepower range at speeds from fractional rpm up to a present limit of 30 rpm. Torque ratings range up to 80 in.-lbs.

The Enercon motor—based on oscillating motion but with a completely new approach to the utilization of this energy—was designed by James S. Neal, vice president of Energy Conversion Systems Corp.

Most of the design advantages flow from the direct drive ability of the motor and include:

—Accurate detent within 5 min. of arc.

—Wear factors at least equal to conventional systems and up to 10 times greater in some applications.

—Efficiency of about 85%.

—Forward, reverse or even alternating rotation with both speed and direction set or adjustable by manual or automatic methods.

In addition, company executives say the Enercon concept will result in savings from 10 to 50% over conventional motors in every application investigated —and these range from missile/space through kitchen appliances. A market survey run by the company indicates an immediate sales potential of $50 million annually, with a long-range potential several times this figure.

• **Alternating Power Source** — Enercon has two major design innovations that overcome the limitations of electric motors based on the oscillating principle. The approach greatly increases available power and completely eliminates the problem of translating oscillating motion into rotary motion.

Oscillating motion is produced by two magnetic fields in direct opposition. The power system consists of two magnets. One is a permanently polarized ceramic while the other, an electromagnet, changes polarity with reversal of electric current direction.

The forces of attraction and repulsion are used to generate a power stroke with each oscillation through a cam-and-wedge device to a shaft (see box). Wedging chambers can be cut to supply motion in either or both directions.

Rotation speed is controlled by limiting the amount of oscillator travel. Several modes of control are possible. An Enercon unit can be factory or customer pre-set for a desired rotational

speed or adjusted manually to any speed within its range.

Speed can also be changed by automatic means or varied continuously throughout its range. Models are available with programers that allow settings for stops and starts at multiple points around the circle of rotation within 5 min. of arc accuracy.

The bearing points of the rollers against both shaft and wedge chamber constitute the only wear areas—service life then depends on the hardness of the materials selected for these surfaces. Extended operation is possible without lubrication.

The present upper limit for single motors is at about 1 hp., but higher ratings can be achieved through ganged power units on a common shaft. Oscillator travel ranges from 0 to 0.030 in. with full torque instantly available.

Patent applications have been made on the development.

Enercon has three specific disadvantages in space applications, says Neal. There is no inertia and sometimes this is desirable. Secondly, extreme vibration has a detrimental effect, although the motor can be insulated. But Neal says the vibration threshold is beyond that of comparable conventional units.

The third disadvantage is associated with the alternating current requirement —there may be situations where it is not available. Minor limitations may crop up in the inverter or any other component used to convert direct current to alternating current. The Enercon is frequency sensitive. Drastic voltage changes also affect its speed.

Like all electric motors, the Enercon needs a constant power supply.

Besides the 17° wedge-angle, the other major contribution to the success of the Enercon principle is the ceramic magnet. It is completely without permeability and functions in a magnetic field without being de-magnetized. A foreign field would have to be several orders of magnitude more than those planned to even cause a reversal of polarity in the ferrite magnet.

Neal says his firm is capable of handling special motors for space applications, but each case would have to be negotiated. While the motor itself may be extremely simple, major specification changes, such as repeatability within five seconds of arc, would involve a considerable amount of engineering.

But Neal is confident there are many applications where only a minor modification is needed—bringing the motor cost down to its commercial figure or just slightly higher. Close control of tolerances is necessary, whether the Enercon unit is to power a can opener or function in orbit. ⌘

## How Enercon Motor Works

ENERCON'S direct-drive, low-speed rotary motion is produced through oscillations generated by opposing magnetic fields. The one-piece metal oscillator surrounds and imparts motion to the shaft at left. Its energy pickup is in the E-shaped configuration at its right end.

A coil, connected to 60-cycle, 110-volt a-c current, is wound around the center pole of the E-shaped oscillator—creating an electromagnet when current is applied. Since the current is alternating, the polarity of the electromagnet reverses 60 times per second.

The poles of a permanently polarized ferrite magnet fit into the oscillator pole gaps, creating four sets of working pole faces. For purposes of explanation, assume the ferrite magnet is positive at its top pole in the drawing and negative at the bottom.

With current flowing through the electromagnet in one direction, the upper arm would be positive, the center arm negative and the lower arm positive. The forces of attraction and repulsion so created would cause oscillator motion in a counter clockwise direction—assuming the shaft center at left is a fixed point. Reversing the polarity of the E-magnet occurs upon current reversal and creates clockwise oscillator motion.

The snubber springs and adjustment wedges illustrated control the amount of oscillation, and hence the speed of rotation.

Transmission of motion occurs where the oscillator surrounds the shaft. Three wedge chambers are cut into the metal oscillator with a 17° wedge angle. Rollers that bear against the shaft are inserted into the wedge chambers together with roller springs that bear against both the rollers and one face of the wedging chamber.

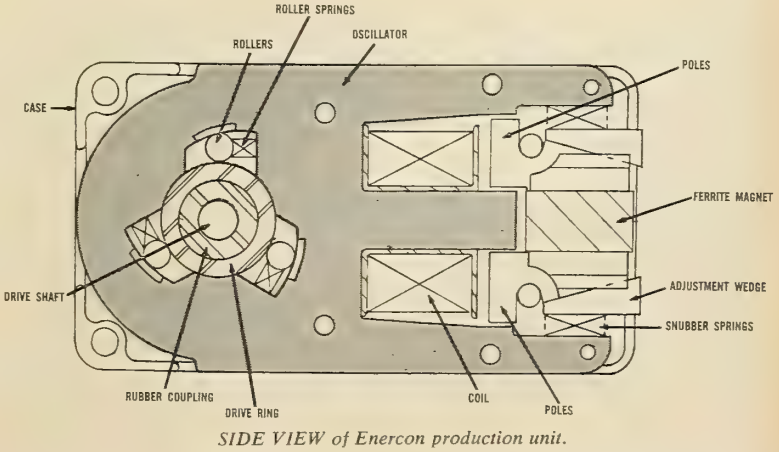
As the oscillator moves clockwise, the rollers are wedged against the shaft, imparting minute increments of motion to the shaft. Counter-clockwise motion releases the wedging pressure and the rollers are returned to the bite position by the springs.

A similar set of wedge chambers and rollers is built into one side-plate or one side of the case. This configuration is not displayed in the side view below, but takes advantage of the second driving mechanism resulting from the slight motion generated by oscillation of the case and oscillator with respect to each other.

Thus the wedge-roller system in the case or side plate imparts another increment of motion to the shaft while the oscillator wedge-roller combination is in the release position.

Since the order of motion is only a few thousandths of an inch, the double power impulse with each complete oscillation will be present except in extremely rigid mounting e.g., the Enercon case welded to another structure. In this mounting situation, the side plate wedge-roller system acts as a brake to hold the shaft for the next oscillator power impulse.

But almost all the mounting means envisioned in foreseeable applications will permit the extremely small—but significant case movement. ⌘




*SIDE VIEW of Enercon production unit.*

# LEM Award Caps Long Grumman Drive

***Management team takes shape; no new facilities buildup seen; a review of the company's three-year push for an Apollo contract***

**by Michael Getler**

BETHPAGE, L.I., N.Y.—Grumman Aircraft Engineering Corp. is now embarking on what must rank as one of the most dynamic programs in the U.S. lunar effort—design and development of the vehicle in which American astronauts will actually land on the Moon.

Though some aspects of Project *Apollo* call for larger funding, and though complete success of the mission cannot be achieved without perfect performance from all dependent systems, the fact that a Grumman-built vehicle may touch man down on the lunar surface for the first time has had a tremendous impact on all Grumman employees.

In the president's chair at Grumman, 57-year-old E. Clinton Towl points to his rank-and-file worker as the major factor in the firm's successful pursuit of NASA's estimated $350-million contract for the Lunar Excursion Module. (Overall average length of employment at Grumman is 10 years, company officials note, a figure far beyond the aerospace industry average.)

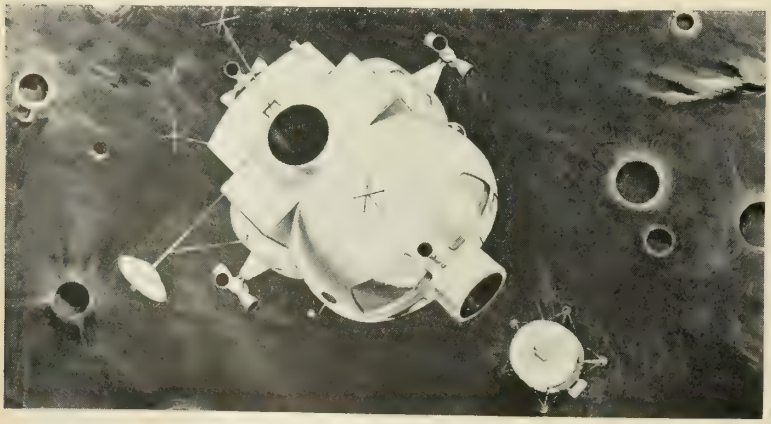
However, Towl, who has been with Grumman since the company was founded in 1930, feels that the LEM award—while inherently bold in concept—signals a degree of caution and conservatism at this point.

Commenting on the plaudits which have come to Grumman in the early rush of enthusiasm since the firm won the stiff industry competition, Towl cautions: "Don't congratulate us now. Come and see me in 5-6 years, after we've got those men to the Moon and back safely. Then I'll be glad to shake hands."

Towl, late in November, headed a 60-man technical and administrative team which left Bethpage for NASA's Manned Spacecraft Center at Houston to negotiate final details on the LEM contract. Signing is expected later this month.

Commenting on reports that the figure may be significantly beyond the original $350-million estimate, Towl said only that this would have to involve a change in the scope of the contract. First subcontract awards are expected shortly after the first of the year, when the major development effort is to get under way.

Though no subcontractors have yet been named, there is wide speculation that RCA-Princeton, a collaborator with Grumman on guidance portions of the LEM proposal, may wind up with a contract to build the MIT-designed system (M/R, Nov. 12, p. 12.) It is also reported that competition for the LEM propulsion system is now somewhat more broadly based than earlier reports indicated.



*GRUMMAN ARTIST'S concept, newly released, shows Lunar Excursion Module taking off from Moon after two-man crew has completed its historic mission.*

• **Space drive**—The Grumman success on LEM has climaxed an orderly march towards prominence in space. The company hopes that in the long run this will equal the prominence achieved by the firm in the aircraft industry.

Grumman began collecting talent and funding company studies on space in the early 1950's. In the past 4-5 years, a company spokesman says, the firm has plowed more than $13.5 million into its expanding in-house space facilities.

In 1961, Grumman opened a $5-million, 65,000-sq.-ft. electronic systems center, which in addition to several laboratories houses the largest indoor RF anechoic chamber in the U.S. Also in '61, mostly in support of the firm's efforts on the *Orbiting Astronomical Observatory* (M/R, Dec. 4, '61, p. 16), Grumman added a 40-ft.-dia. centrifuge rated at 80,000 g-lbs., a 17 by 26 ft. high-vacuum environmental chamber capable of $10^{-7}$ mm Hg levels, a 30,000-lb. electrodynamic shaker, and a temperature- and humidity-controlled clean room large enough to handle completely assembled models of the spacecraft.

Early in 1962, Grumman put into operation a $150,000 stabilization and control dynamic test facility, developed initially to support the effort on the highly sensitive *OAO* stabilization and control system. Included in this area is what is reported to be the largest 3-axis air-bearing spatial simulator.

Next month portions of the new $5-million space engineering center will be available for first elements of the LEM engineering team. The entire 210,000-sq.-ft. building is expected to be completed in May.

• **Facilities available**—The net effect of this corporate planning for space, Towl told M/R, is that no new test or fabrication facilities beyond



*PRESIDENT E. CLINTON TOWL . . .*
*"Shake my hand in 5-6 years . . ."*

those already available or soon-to-be at hand will be required by the firm to handle LEM.

One exception, according to Grumman sources, may be additional environmental test chambers. It is not yet clear whether the firm will build a vacuum chamber even larger than the one designed to house *OAO*, or whether it will use facilities existing elsewhere for the space simulation trials.

The award to the firm of a major portion of the interservice TFX aircraft contract, close on the heels of the LEM award, also is not expected to pose any facilities bottleneck. Presumably this was looked into by DOD prior to making the award. Pending completion of negotiations, officials are making no estimates as to when TFX will move into a concerted development effort at the plant.

Signing of the LEM contract this month will bring Grumman's share of major space awards to an aggregate approaching $0.4 billion. On an annual basis, the space contracts—*OAO* and LEM—should lift the company's level of income from space projects to about 20% of gross annual sales for the near future. Some observers believe the *OAO* contract, now valued at about $30 million, may have a significant growth potential.

TFX monies will certainly affect this figure, although the timing is still difficult to predict. The remaining income is almost entirely from military and civilian aircraft sales and a growing hydrofoil development effort.

Until its success with LEM, Grumman's award late in 1960 for the *OAO* represented the only big space award which had come to rest in this highly concentrated industrial area. The claimed neglect of Long Island was the cause for much clamor, particularly in recent months, by local congressmen, businessmen, politicians, and financial interests.

A move has been under way here for more than a year—with sponsorship from more than one organization—to set up some sort of group in Washington to more effectively present the area's capabilities. Cooperation among the major primes and the more than 50 major subcontractors in this area would be essential.

Some observers believe the high expenses needed to do an effective job, plus the uncertain benefits to contributing firms, may prove to be insurmountable problems in launching the enterprise.

However, these plans are still in the works and opinion varies as to the effect of the individual Grumman success, both with LEM and TFX. Some feel it will speed the project along, others believe it will throw a damper of contentment on the area. Long Island industry leaders expect some action to unfold here within the next few months.

• **3-year drive** — Grumman's effort on LEM caps a three-year drive, costing about $2 million, which the firm has made to secure a chunk of *Apollo*. Though unsuccessful in its bid on the *Apollo* command module last November (Grumman was major subcontractor to GE on a joint proposal), the firm showed early recognition of other possible approaches to the lunar landing, proposing lunar-orbit-rendezvous using a LEM-type vehicle as one of the alternates.

By the time NASA made the decision to go that route last July, Grumman had already gained valuable experience in development of the excursion module, for which it had not given up hope. Once the competition was announced, Towl asserts "We made up our mind that we were going to win it, and conducted ourselves accordingly."

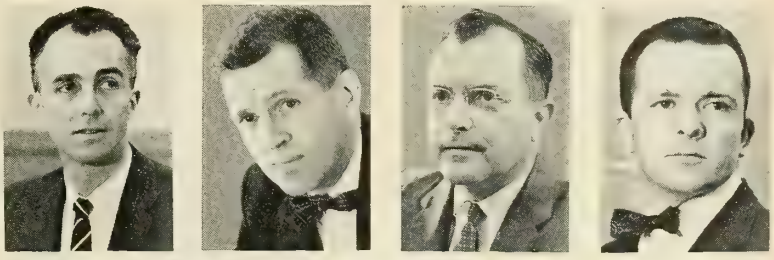
Shortly after the first of the year, Grumman plans to begin the gradual build-up in personnel on LEM. This will probably take about 1½ years and include hiring of about 600 new persons, nearly all technical types. Towl says no new management hiring is contemplated.

Though the program was still young, the LEM management team took shape rapidly. The same men charged with key roles in the proposal effort (M/R, Nov. 12, p. 12) occupy top berths in the development program. Riding herd on the operation from the front office will be William T. Schwendler, chairman of Grumman's executive committee and Towl's business associate for more than 30 years.

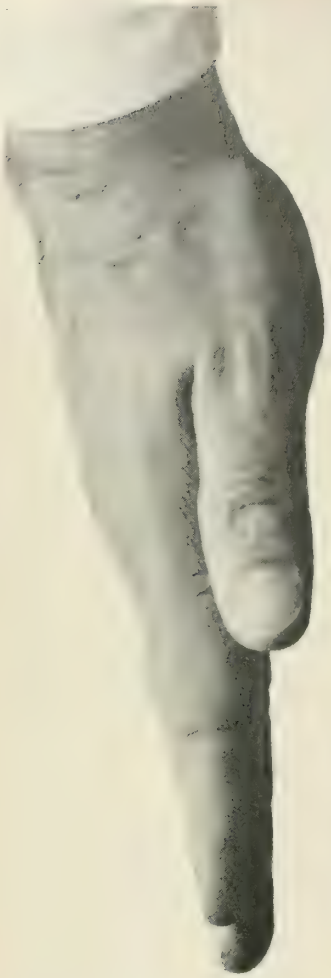
Organized on a project basis, as are all Grumman programs, LEM will first fall within the province of Space Programs Director Joseph G. Gavin, Jr. (16 years with Grumman). He will report directly to Schwendler. Supporting Gavin, who led the firm to second place behind McDonnell Aircraft Corp. in the Project *Mercury* competition, will be LEM program manager Robert S. Mullaney (17 years with the firm). Engineering manager will be 20-year man William Rathke. Thomas J. Kelly, director of the firm's technical studies on the *Apollo* mission since April, 1960, has been named project engineer. Kelly has been with Grumman for 8 years.

In a post-LEM, pre-TFX interview, Towl said "the chances of us winning another major space contract in the next six months are slim." However, Grumman engineers, in addition to those from Space Technology Laboratories and Northrop Corp., will soon present results of a NASA-funded study of a multiple-payload *Lunar Logistics Vehicle* (*LLV*). If a go-ahead is given on *LLV* development sometime next year, a contract could run to $150 million. Some observers believe Grumman's chances of a systems management contract in this area are diminished, but they hold out the possibility of hardware contracts for portions of the payload.

There are also reports that NASA is considering use of the LEM vehicle to replace *LLV* as a means to drop equipment on the Moon before the *Apollo* landing (M/R, Nov. 26, p. 61). ⌗



*TOWL'S TEAM (left to right): Space Programs Director Gavin, LEM Program Manager Mullaney, Engineering Manager Rathke; and Project Engineer Kelly.*



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**(B)** developing range technology concepts required for launches in the near future (Dyna-Soar, Gemini, Apollo test vehicles, advanced Saturn boosters and Nova);

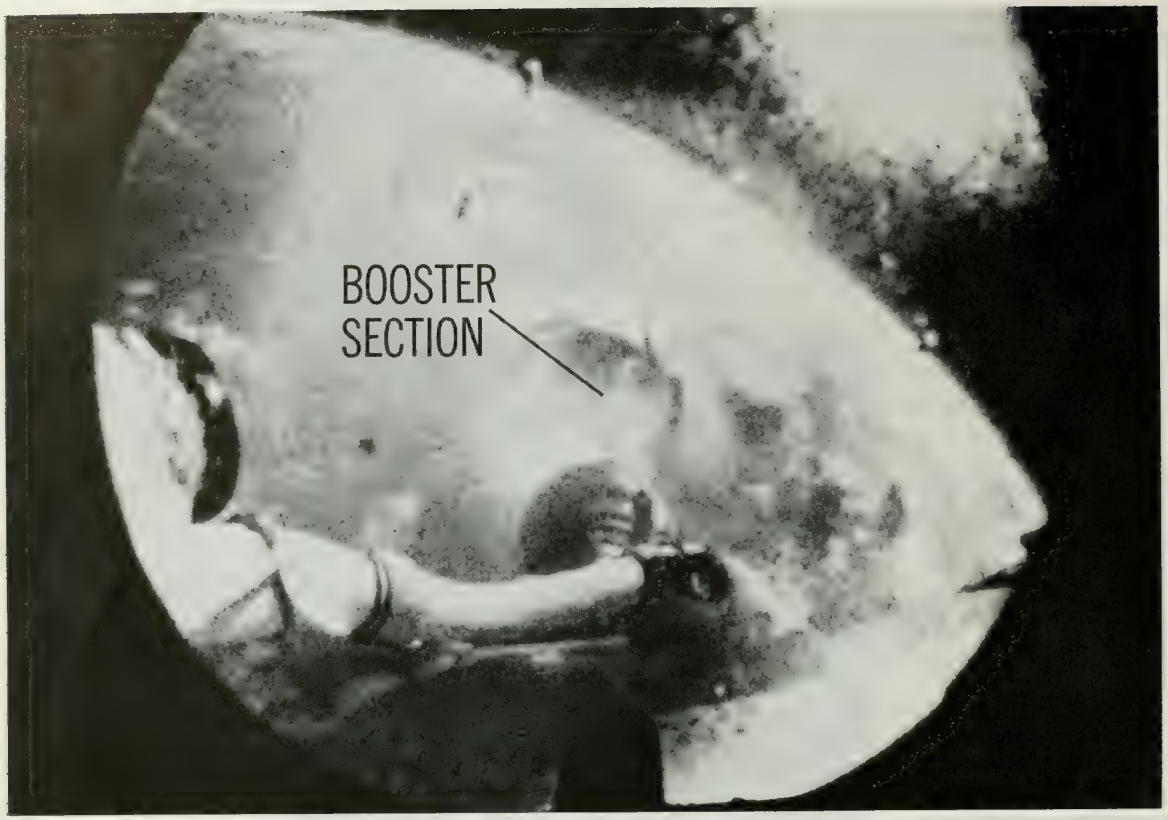
**(C)** advanced planning, looking forward as much as 15 years. Includes considering such problems as how to service, launch, track and recover information from multi-million pound thrust booster systems and anticipating the problems associated with the launching and support of nuclear propelled boosters and spacecraft.

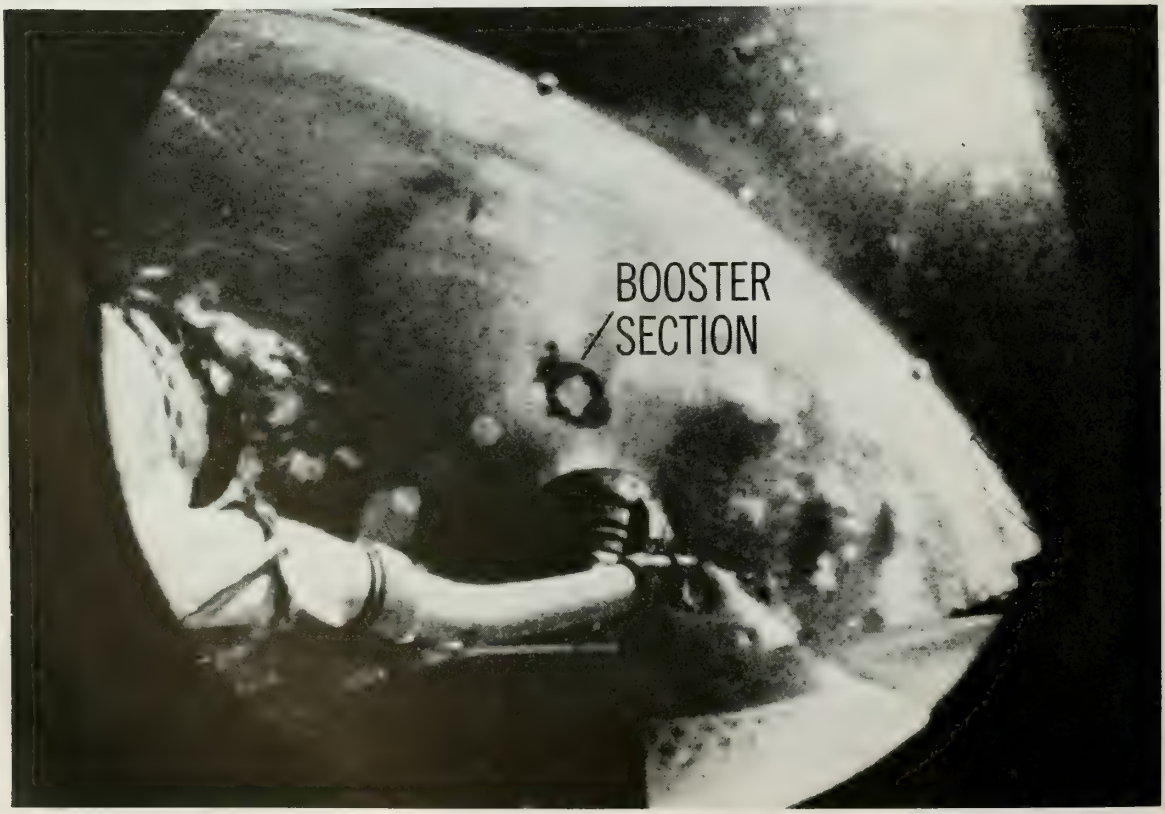
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# Motion Pictures Capture Atlas Staging

RECENT FLIGHT from Cape Canaveral of four high-speed motion picture cameras aboard an *Atlas F* produced footage including the two frames at left. The cameras recorded in slow motion on color film exact details of *Atlas* liftoff and staging.

Though motion picture cameras have been carried aloft previously in *Atlas* nose cones, the current program marks the first time onboard cameras have recorded details of actual *Atlas* staging.

The top left photo, taken at 50-mile altitude, shows separation of the booster section from the *Atlas*. The two-engine section, just jettisoned, is still within the flame pattern of the remaining sustainer engine.

In the lower left picture, the booster section is clearly discernible as it plummets toward Earth. The *Atlas* sustainer engine continues to burn, as the partly blackened booster engines fall away from the missile. The center hole visible in the booster section fits around the sustainer engine.

• **Advantages of filming**—General Dynamics/Astronautics and the Air Force have been experimenting with this photo technique for several months, in flights over both Atlantic and Pacific Missile Ranges.

Goal of the project is to open up new possibilities in the field for inflight instrumentation. Though highly reliable data have been produced by telemetry and long-range tracking techniques, they have failed to spell out sufficiently precise details to please engineers.

Prime advantages of the filming procedure is that it provides a permanent visual record of the liftoff and staging functions. The films can be viewed repeatedly, and motion can be stopped for close inspection.

• **Camera installation**—Recent experiments involved two different types of camera installations, one for liftoff coverage and another for staging.

Liftoff cameras are positioned inside aluminum housings, and self-hardening polyurethane foam is poured in around the camera, forming a two-inch buffer pad. The completed units, each weighing about 35 lbs., are positioned on the exterior of the thrust section, focused on inside plumbing and on the sustainer engine through quartz-glass openings in the section walls. (Liftoff camera installation is shown in photo below.)

A 14-ft. parachute is mounted inside the camera housing, and explosive separation ejects the entire unit down through the engine exhaust system. Despite parachute braking, these units generally impact at about 50 mph.

GD/A acquires the staging camera units intact, encased in longer aluminum cylinders than the liftoff units. These are usually mounted on the aft end of the missile tank and focused on the exterior of the thrust section. They operate when the *Atlas* is about 50 mi. up and about 50 mi. downrange.

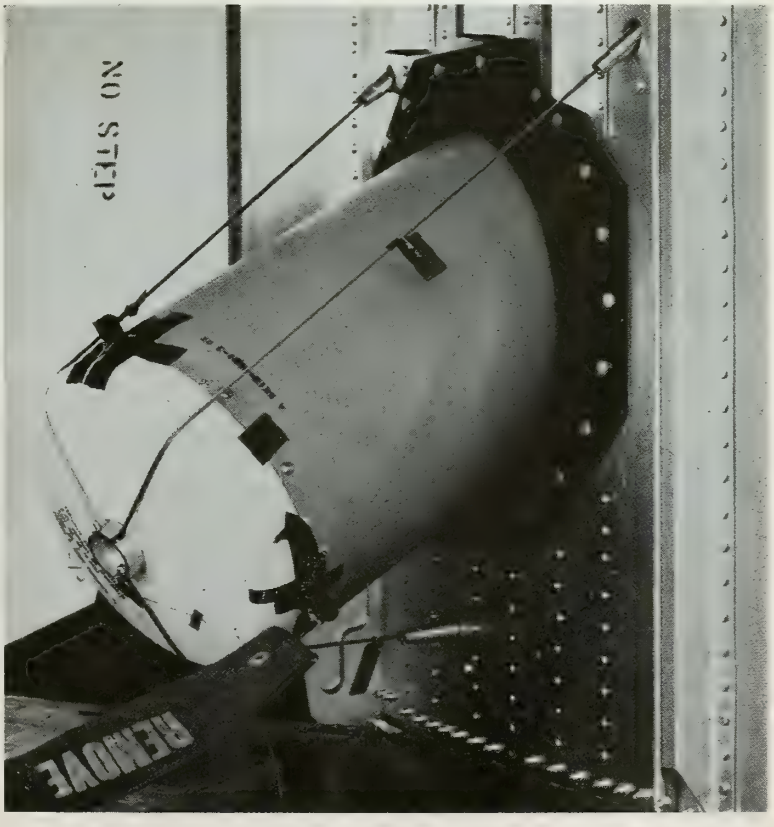
As they are ejected over water some distance from the launch area, the staging cameras use—instead of a chute—a paraballooning unit that lowers them to the water and provides flotation pending recovery. Included in the package are chaff material for radar tracking, a flashing light beacon and a homing signal transmitter.

• **The cameras used**—Each of the D. B. Milliken 16-mm cameras used for the project has a 400-ft. film capacity. Two DBM 4 models were used in the liftoff units, and two DBM 3's were installed in the staging units.

One liftoff camera was operated at 400 fps with a shutter speed of 1/1000 sec., and the other at 32 fps at 1/80 sec. Both staging cameras had a filming rate of 400 fps, with an exposure of 1/1000 at f/8.

To provide a 55° view of the interior of the thrust section, liftoff units carried 10-mm Angenieux lenses. Pacific Optical Periphoto lenses on the staging cameras provided 110° views of the thrust section and the sustainer engine.

A modified SG-65 Sylvania Sun Gun high-silica/iodine lamp mounted on the thrust section provided 3200 foot-candles of added light. According to Sylvania spokesmen, this was the first application of the recently developed light source to onboard filming of rocket functions. Each Sun Gun and each camera unit was powered by a small 28-volt battery. ❖



# RIFT Poses Transportation Headache

***Lockheed building special handling system, will spend heavily to make 435-mi. route passable***

**by Robert Lindsay**

SUNNYVALE, CALIF.—The most difficult ground transportation problem yet tackled by the missile/space industry has been posed by the immense *RIFT* nuclear rocket stage under construction here.

To meet this, Lockheed Missiles and Space Co., *RIFT* contractor, has devised a unique ground handling system for *RIFT*. It is planned so that use of cranes or any other lifting operations can be avoided from the time the vehicles leave here until they are mated with lower stages just before launch or test.

In addition to moving flight-test vehicles from California to the Atlantic Missile Range, Lockheed must also move four stages over a long mountain and desert route from the California coast to the Atomic Energy Commission's Jackass Flats, Nev., proving ground for static tests.

The *RIFT* vehicle, 33 ft. wide and about 75 ft. long, will be too big for many existing roads; Lockheed must build new roads, widen others, strengthen bridges and remove or relocate thousands of obstacles in order to get through to the Nevada site.

The load being moved is essentially a monolithic, thinskinned steel tank for the liquid hydrogen which will fuel the Aerojet-Westinghouse nuclear engine to be used in the *RIFT (Reactor In-Flight Test)* program. The engine will be mated to the tankage at the test site.

Lockheed will fabricate the vehicle in a converted dirigible hangar at Moffett Naval Air Station, adjacent to LMSC's main plant here. Construction of 10 stages has been authorized so far. First static tests are scheduled in 1964, and flight tests in 1966.

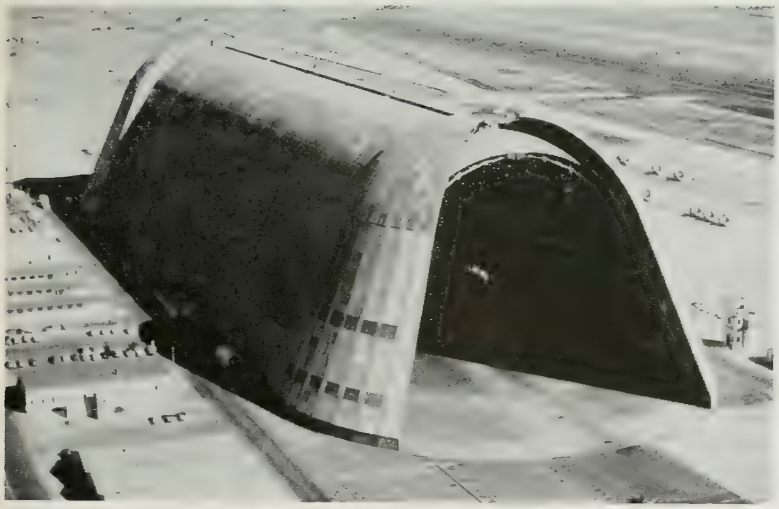
• **Overland trail** — Lockheed surveyed many possible routes in seeking the best way to get the vehicles to Nevada. Tentatively selected is a 435-mile run from Port Hueneme on the California coast that crosses into Nevada via a roundabout routing of city streets, highways and country roads. Other routes are still under consideration, although Lockheed now regards the one chosen as likely to be used.

Louis Molinari, Lockheed transportation analyst in charge of the program, said that because the size and weight of the vehicle "far exceeds" capacity of roads to accommodate it, the route must be extensively "remodeled." "In some places," he said, "we'll leave the present roads and blaze our own through deserts for a bypass over private property."

The *RIFT* stages will range in weight from 60 tons in an initial battleship model to about 40 tons in opera-




*LOCKHEED ENGINEERS recently made a trial run over California-Nevada RIFT route with this road gage trailer, which matches dimensions of 35-ft.-wide stage container. Extra three-foot clearance is required on each side of the gigantic load.*



*READY-MADE "FACTORY" for construction and assembly of RIFT nuclear rocket stages is this former Navy dirigible hangar at Moffett Field, Calif., near Lockheed's Sunnyvale plant. Structure is 198 ft. high, covers eight acres; RIFT will tower 85 ft.*

tional versions. Since California law prohibits highway movement of loads heavier than 38 tons, special permits are required, and the load's transporter must be designed to spread out the weight.

The 33-ft. *RIFT* stage will be encased in an environmental container 35 ft. wide. A three-foot clearance is required on each side for turning, so the minimum clearance required on the route is 41 ft.

Molinari said this is equivalent to "three plus traffic lanes, and we'll be going over two-lane road most of the time."

• **Clearing the way**—Lockheed recently made a trail run on the chosen route with a road gage trailer that had dimensions identical to the *RIFT* stages.

Molinari said the trip confirmed the route is feasible, although in some spots clearance is only six inches over the minimum and a major reconstruction project, costing several hundred thousand dollars, is needed to make the route passable.

Molinari estimates that 4000 telegraph and telephone wires, electric wires and transmission lines, guy wires and telephone service lines must be removed or repositioned before the *RIFT* loads can pass. Average height of wires that cross above highways is 18-22 ft., half the required clearance for *RIFT*.

In most cases, the wires will be moved out of the way by lengthening poles. But about 200 will have to be removed. About 400 trees must be cut down or trimmed back, and hundreds of signs and road markers are in the way.

Dips will impair passage of the 100-ft. transporter at some points, so some road crowns must be scraped and dip "valleys" filled in. Several tight turns must be widened and weak bridges enroute must be temporarily strengthened to take the heavy load.

In several places existing roads will be unnavigable and new roads will be built by Lockheed. The longest custom-made road will be a seven-mile stretch that will be bulldozed around the California desert city of Barstow, Molinari said. Most of the trip will be over desert, including a corner of Death Valley.

The steepest grade will be about 7%. Use of a "pusher" tractor behind the load is being considered.

Molinari estimates the trip from Port Hueneme to Jackass Flats will take five working days, with the load moving at 10 miles an hour.

Present schedules call for completion of road modifications and obstacle removal three months before the first *RIFT* stage is moved to Nevada in 1964. Molinari said the construction work will take about a year.

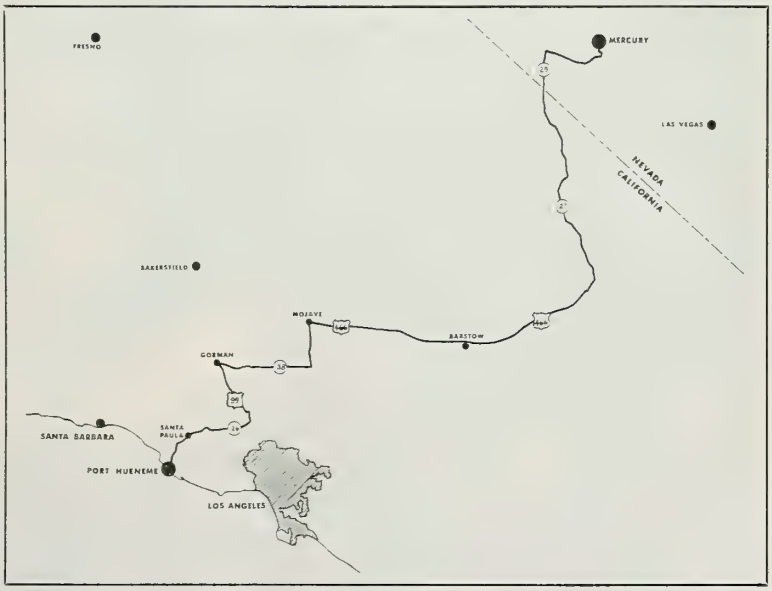
• **Unique vehicle**—The *RIFT* transporter, now being designed by Lockheed, will be a multi-axle, multi-wheeled vehicle built about 15 inches above ground. Its rear wheels will operate independently, like a fire engine hook and ladder truck, for easy turning. The transporter will be broken down for shipment back from either Jackass Flats or AMR.

The stages will be encased in a container regulated for humidity, temperature and internal pressure. A complex shock absorption system on the transporter will limit impact on the load to two g's lateral force and one vertically.

The stages will be loaded on the road transporter at the production plant and will not be removed until reaching Nevada or AMR. Besides the main tankage vehicle, a 40-ft.-wide nose fairing built here will be moved to Canaveral.

To eliminate lifting and transferring of the stage, the transporter will be mounted on a barge and floated into a specially modified LSD (Landing Ship Drydock) which will receive the barge.

During the 13-day sea voyage through the Panama Canal, the transporter will be floated out of the ship, still on its barge, at Port Hueneme or at the mouth of the Mississippi, where it will be barged to AMR. The transporter will then be rolled off the barge from a special dock, at high tide. ❖




*MAP SHOWS tentatively planned 435-mi. run from Port Hueneme to Nevada site.*

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Gemini docking simulator
being built for NASA by McDonnell.



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## Industry Facilities

Genisco, Inc., will move this month to a new plant at the Dominguez Industrial Park, Compton, Calif. The electronics firm's record sales for the past fiscal year necessitated the expansion. . . . *Philco Corp. has opened a corporate sales office in Houston for all Philco sales representatives except those of its Consumer Products Div., who will remain in Dallas.* . . . Union Carbide Corp.'s Linde Co. has increased its liquid oxygen and nitrogen production by 450 tons per day in an expansion of its Fontana, Calif., plant. The plant is the largest of its kind in the West, second largest in the U. S. . . . *At a newly opened office in the Holiday Office Center, Huntsville, Ala., Reynolds, Smith & Hills, architectural and engineering firm, is presently doing design criteria for the launcher-umbilical tower (LUT) that will transport Saturn C-5 from the Vertical Assembly Building to the launch pad. LUT uses the crawler transfer concept.* . . . New occupant of the Newton, Mass., Industrial Center is the newly formed Guillemin Networks, Inc., which will develop and market special-purpose filters incorporating modern network synthesis theory and technology. . . . *Grumman Aircraft Engineering Corp., recent winner of NASA's LEM competition, has opened a liaison office near the Manned Spacecraft Center at Houston. Jack Buxton will manage the new office.* . . . Conductron Corp., Ann Arbor, Mich., is building a new $8-million, 400,000-sq.-ft. campus-plan complex at the edge of the University of Michigan's North Campus, on a 62-acre site. An aerospace R&D firm, Conductron specializes in research related to lunar surface layers. . . . *Adler Electronics, Inc., New Rochelle, N. Y., now operates a Cocoa Beach, Fla., regional office to serve the Cape Canaveral Area. Adler produces telecommunications systems and other communications gear.* . . . Lockheed Missiles & Space Co. will build a Huntsville, Ala., Research and Engineering Center on an 80-acre site in the Industrial Research Park adjacent to the University of Alabama Research Institute. Nucleus of the center's staff will occupy leased quarters in January, and the first building will be completed next October. . . . *To meet increasing market-support requirements relating to present and future national space programs, Garrett Corp. has opened three new regional sales offices—in Cleveland, Ohio, New Orleans, La., and Cocoa Beach, Fla. With the new branches, Garrett now has a total of 24 offices at key locations in the U.S. and Canada.*

## New Industry Representatives

The Carter-Princeton Div. of Carter Products, Inc., has named the F. O. Hoyt Co. to expand and supervise C-P's sales representative organization. C-P's products include semiconductor junction devices, power supplies and other electronics materials. . . . *Asco Sintering Corp., manufacturer of powdered metal products, has appointed Brown Bearing Co., Seattle, as its sales representative for Oregon, Washington, Idaho and Montana.* . . . Guillemin Networks, Inc., has named P. J. Engineering Sales Co. exclusive sales representative in Maine, New Hampshire, Vermont, Massachusetts and Connecticut for GNI's line of electric wave filters and special-purpose networks. . . . *Jarry Hydraulics Ltd., an associate company of Dominion Brake Shoe Co. Ltd., will manufacture Resistoflex Corp.'s Fluorex-T aerospace products in Canada under a new agreement.* . . . Electronics Marketing Corp., Columbus, Ohio, will distribute General Electric electronic capacitors. EMC will operate in Ohio, Indiana, Kentucky, Tennessee, West Virginia and western Pennsylvania. . . . *Leff & Eader Corp. has been appointed metropolitan New York City sales engineering representative for Hammarlund-COC (Centralized Operations Control) products and systems, produced by Hammarlund Mfg. Co., a Giannini Scientific company. The Hammarlund-COC line includes tone transmitters and receivers, electronic scanners and other remote control, data transmitting and telemetering gear.* . . . Rivett Lathe & Grinder, Inc., Boston, has named Richardson Equipment Co. Limited, Scarborough, Ontario, Canada, as exclusive distributor in Ontario province of RLG's hydraulic valves and cylinders.

## Industry Plans Fewer Exhibits

Missile/space firms plan sharp curtailment of their exhibit participation in 1963 meetings, a recent survey by the Aerospace Industries Assn. shows. In response to an AIA query, 42 member firms gave overwhelmingly negative replies to questions whether they will present displays at nine different events in the coming year.

Here are some of the results: Navy League—25 no, 2 yes, 14 undecided; Air Force Assn.—20 no, 3 yes, 17 undecided; Assn. of the U.S. Army—14 no, 10 yes, 18 undecided; American Rocket Society—18 no, 6 yes, 17 undecided.

## Philco Sets New Computer Rent Plan

Philco Corp. has announced what it calls "an entirely new concept" in computer rental rates. Designated PACT (Pay Actual Computer Time), the plan allows user to pay a basic monthly rental plus an hourly use rate.

Normally, most data-processing equipment is either sold outright or leased on the basis of a 200-hr. month. Under a standard contract, rental is a fixed amount whether computer is used or not.

Under the new plan, a Philco spokesman said, "you can save money when you use the computer —and you save money when you don't use it."

# AWARDS

## AIR FORCE

$5,372,062—**Aerospace Corp.,** Los Angeles, for systems engineering and technical direction of ballistic missile and space programs together with management services and administrative support. Work to be done at El Segundo, Calif.

$3,500,000—**Martin Marietta Corp.,** New York City, for research and development work on a vehicle for a space program. Work to be done at Baltimore.

$3,500,000—**Philco Corp.,** Philadelphia, for work on control subsystems for space programs. Work to be done at Western Development Laboratories, Palo Alto, Calif.

$3,190,396—**International Electric Corp.,** Paramus, N.J., for fabrication and delivery of electronic equipment (supplemental contract).

$2,000,000—**International Telephone & Telegraph Corp.,** New York City, for work on a space communications system. Work to be done at Paramus, N.J.

$2,000,000—**General Precision, Inc.,** Tarrytown, N.Y., for work on a guidance and control system for the mobile mid-range ballistic missile *(MMRBM)*. Work to be done at Little Falls, N.J.

$1,700,000—**General Precision, Inc.,** Tarrytown, N.Y., for development of *X-20 Dyna-Soar* spaceflight simulation chamber.

$1,500,000—**N. T. W. Missile Engineering, Inc.,** Los Angeles, for work on large rocket motor cases.

$1,414,000—**General Dynamics Corp.,** New York City, for work on design and development of a standard space launch vehicle. Work to be done at San Diego.

$1,328,048—**Sperry Rand Corp.,** Great Neck, N.Y., for electronic altimeter components.

$1,000,000—**General Electric Co.,** New York City, for work in connection with installation and checkout of *Atlas* missiles. Work to be done at Philadelphia.

$1,000,000—**American Air Filter, Inc.,** St. Louis, for work on *Minuteman* control systems.

$1,000,000—**Collins Radio Co.,** Dallas, for technician services on communication/navigation equipment.

$1,000,000—**Thiokol Chemical Corp.,** Brigham City, Utah, for development of *Minuteman* motors.

$125,000—**Leeds & Northrup Co.,** Philadelphia, for potentiometers for use in calibration checks on instruments at missile bases.

## ARMY

$5,400,000—**Hughes Aircraft Co.,** Fullerton, Calif., for *Nike* and *Hawk* missile fire control equipment.

$4,036,932—**Western Electric Co,** New York City, for guidance systems for *Nike-Hercules* missiles.

$1,241,296—**Space Corp.,** Garland, Tex., for shipping and storage containers.

$1,065,500—**Raytheon Co.,** Lexington, Mass., for *Hawk* system components. Work to be done at Andover, Mass.

$300,000—**Melpar, Inc.,** Falls Church, Va., for speech-compression communications system.

$166,312—**Graham Contracting, Inc.,** Orlando, Fla., for construction of a spin test shop.

## NAVY

$7,000,000—**General Electric Co.,** New York City, for electronic guidance assemblies for the *Polaris* missile. Work to be done at Pittsfield, Mass.

$4,000,000—**Raytheon Co.,** Sudbury, Mass., for electronic assemblies for *Polaris* guidance equipment.

$3,075,000—**Douglas Aircraft Co.,** Santa Monica, Calif. for classified electronics equipment.

$3,000,000—**Minneapolis-Honeywell Regulator Co.,** Minneapolis, Minn., for *Polaris* guidance system components.

$2,600,000—**Hughes Aircraft Co.,** Culver City, Calif., for electronic equipment for the *Polaris* missile.

$1,978,414 — **Northrop Corp.'s Nortronics Div.,** Anaheim, Calif., for engineering and logistics services in connection with *Polaris* missile checkout equipment.

$1,864,805—**General Electric Co.,** Schenectady, N.Y., for additional stock components for nuclear reactor propulsion plants.

$1,798,766—**Douglas Aircraft Co.,** Santa Monica, Calif., for modification of and provision of launch services for the *Thor* missile.

$1,596,335—**North American Aviation, Inc.,** Canoga Park, Calif., for additional funding for *Sparrow III* rocket motors.

## NASA

$2,560,000—**Ling-Temco-Vought,** Dallas, Tex., for development of the velocity package for *Project Fire*.

$1,056,350—**Vitro-Smith Corp.,** New York City, for design, installation and test of a pebble bed hydrogen heat exchanger at the Lewis Research Center.

$967,000—**International Business Machines Corp.,** New York City, for designing an advanced data center at the Marshall Space Flight Center.

## INDUSTRY

$27,610 000—**Hughes Aircraft Co.,** Los Angeles, from **Boeing Co.,** for electronic data-analysis systems for the *Minuteman* missile.

$1,700 000—**American Metal Products Co.,** Detroit, from **Thiokol Chemical Corp.,** for blast tube inserts.

$1,500.000—**Perkin-Elmer Corp.,** New York City, from **Sylvania Electric Products, Inc.,** for instruments for *Orbiting Astronomical Observatory*.

$1,400,000—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., from **Collins Radio Co.,** for memory units.

**Bulova Watch Co., Inc.,** New York City, from **Hughes Aircraft Co.,** for transistorized timer for *Syncom* communications satellites (undisclosed amount).

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Base Procurement Office
McGuire Air Force Base, N.J.

Environmental control modification *"A" Bomarc* missile launcher shelters. Job—IFB 28-609-63-55 (B). Bid opening 12-26-62.

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National Aeronautics and Space Administration
Manned Spacecraft Center
General Research Procurement Office
Houston 1, Tex.
Attn: D. Chilcutt
Phone: WA 8-2811 X7351

Negotiations will be conducted with Somyk Inc., 870 Smithfield Ave., Lincoln, R.I., for development of energy absorbing netting-type body support that will attenuate the transverse peak decelerations and rates of onset transmitted from the space vehicle to the crew member. RFP—MSC-63-361P. Note: For information purposes only; RFP not available.

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Philadelphia Procurement District
128 W. Broad St.
Philadelphia 2, Pa.

Provide 12 man-months of maintenance services for *Sergeant* missiles system 3G52 training device. Work to be performed on site of the devices. Request for proposal has been issued to Aircraft Armaments, Inc., Cockeysville, Md. It is suggested that small business firms or others interested in subcontracting opportunities in connection wtih this procurement make direct contact with that firm.

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National Aeronautics and Space Administration
Launch Operations Center
Procurement and Contracts Office
Cocoa Beach, Fla.

Construction of spare parts building for launch Complex 37 in accordance with contract drawings and specs. Drawings and specs will be included in the invitation for bid. Job—IFB CC-72-3. Bid opening 12-17-62. IFB sets available through 12-12-62, Cocoa Beach, Fla.

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U.S. Army Missile Command
Redstone Arsenal, Ala.
AMCPM-SEPM

*Sergeant* rocket motor XM-419 container, shipping and storage. Drawing No. 9125340—105 each. *Sergeant* guidance XM-420 container, shipping and storage. Drawing No. 9125579—149 each. Destinations to be furnished. Notice is given that available specs and/or drawings relating to this procurement do not fully provide all necessary manufacturing and construction details. Request for proposal has been issued to Sperry Rand Corp., Sperry Utah Co. Div., 322 N. 21st St. West, Salt Lake City 16, Utah. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.

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Procurement Office
White Sands Missile Range, N.M.

System, 10 channel, rack-mountable, FM, with power supply and mixer amplifier—3 each. Delivery to White Sands Missile Range, N.M., IFB-AMC(R) 29-040-63-34(B). Bid opening 1-9-63. Bid sets available through 12-26-62, unless sooner exhausted.

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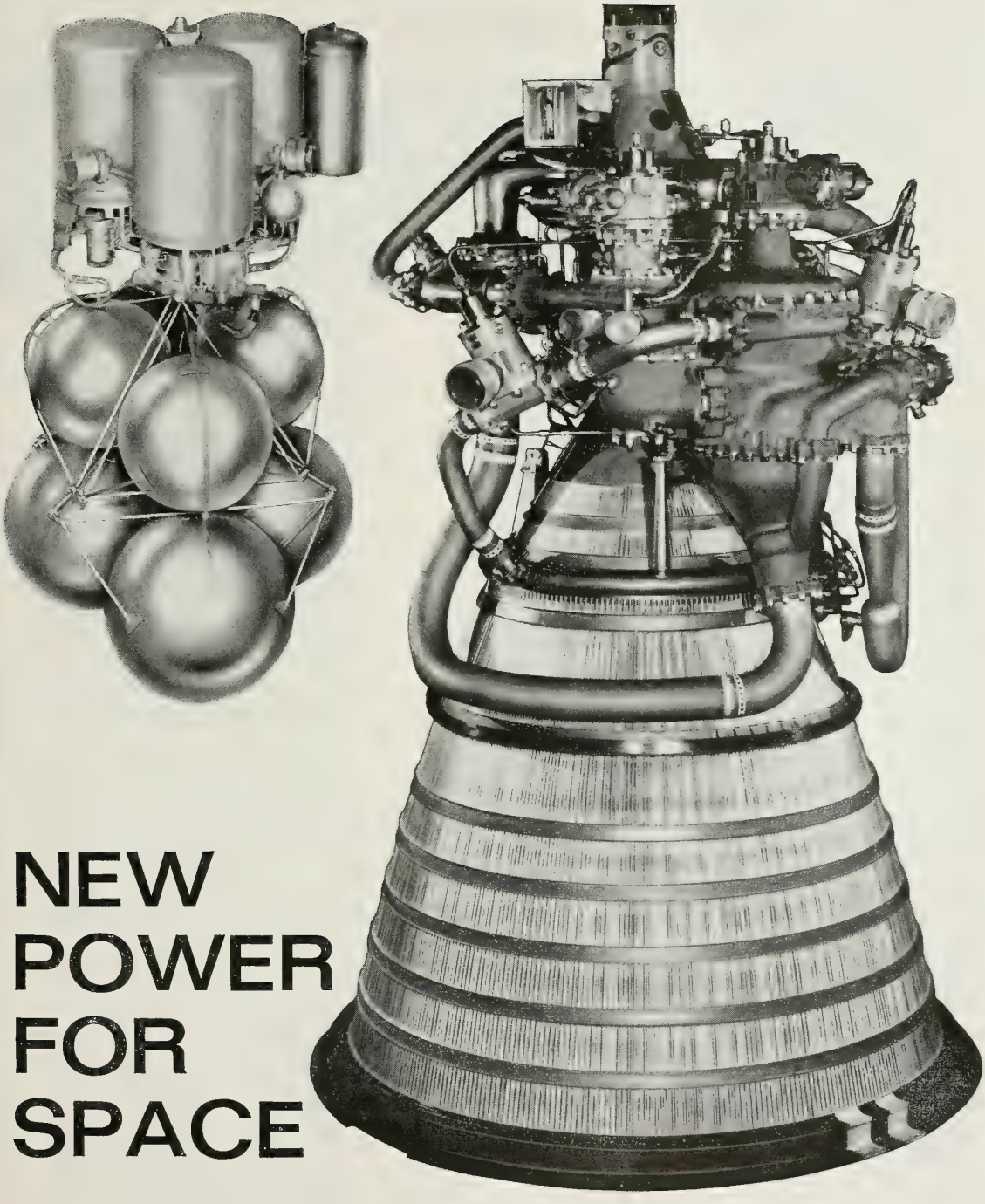
Directorate
Procurement and Production, SAPOS
Kelly AFB, Tex.

Note: Select source procurement. Request for proposals will be issued to the following firm—General Electric Co., 1000 Western Ave., West Lynn, Mass. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this proposal make direct contact with the above firm. 4930-856-9690 leak detector—194 each—in support of missile SM80 and F-105 aircraft. No drawings or specs are available. Deliver to various destinations. P/R SA-3-3984.

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Space Systems Div.
Air Force Unit Post Office
Los Angeles 45, Calif.
SSZDK, Osborne 9-4661, Ext. 4223

162 program mission peculiar equipment including necessary spare parts and ground support equipment to support launch of the 162 program vehicles. This is a continuation of the requirements of 162 program. Negotiations will be held with Lockheed Missile & Space Co., P.O. Box 504, Sunnyvale, Calif. Note: For information only. Request for proposal not available.



# NEW POWER FOR SPACE

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**HEAT TRANSFER ENGINEER**
Degree or equivalent with basic knowledge of radiation conduction and convection heat transfer with application to thermal control of ascent, space and re-entry vehicles. Knowledge of spectrally selective radiation coating, super insulations and thermal vacuum testing is of particular value.

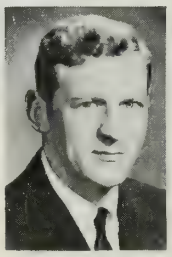
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# names in the news


STIMSON


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FINN

**John D. Stimson:** Named manager of the United AeroSpace Div. of United ElectroDynamics, Inc., Pasadena, Calif.

**Herbert C. Jenkins:** Appointed quality assurance and reliability manager for Burroughs Corp.'s Electronic Components Div., Plainfield, N. J.

**Alexander Kreithen:** Elected a vice president of Documentation, Inc., Bethesda, Md.

**Frank W. Lehan:** Appointed president of Space General Corp., El Monte, Calif. **Dr. Jack E. Froehlich** appointed executive vice president.

**Dr. Milton M. Slawsky:** Director of engineering sciences, AFOSR, elected a Fellow Member of the American Rocket Society.

**Joseph M. Dukert:** Appointed director of public relations for the Research Institute for Advanced Study, Martin Co., Baltimore, Md. **Julian Levine** appointed director of public relations for the Electronic Systems and Products Div., and **Robert L. Mead** appointed director of public relations for the Nuclear Div.

**Edward A. DeCrosta:** Promoted to vice president for atomic instrumentation at Baird-Atomic, Inc., Cambridge, Mass.

**Alan R. Miller:** Named manager of design engineering for Brooks & Perkins, Inc., Detroit, Mich.

**Kenneth H. Drummond:** Appointed Washington, D. C. representative for the Science Services Div. of Texas Instruments, Inc., Dallas.

**Kenneth E. Grine:** Appointed public relations representative for the Missile & Space Systems Div. of the Douglas Aircraft Co. at Cape Canaveral.

**Charles H. Sword:** Appointed director of space and electronic programs at Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif. He succeeds **James C. Elms** who was named deputy director for development and programs at NASA's Manned Spacecraft Center, Houston, Tex. **Paul A. Hanna** named manager of the contract administration office.

**Raymond D. Ouderkirk:** Named manager of systems and procedures at Wyle Laboratories, El Segundo, Calif.

**Dr. H. D. Sprinkle:** Appointed manager of Sylvania Electric Products, Inc.'s System Technology Laboratory, Mountain View, Calif.

**Graeme D. Plant:** Appointed manager of engineering for Kaiser Steel Corp.'s Fabricating Div., Oakland, Calif.

**Dr. F. Robert Naka:** Named technical director for control and sensor systems Development at the Mitre Corp., Bedford, Mass.

**Ira Ritow:** Appointed chief of advanced development at Huyck Systems Co., Huntington, L.I., N.Y. **Herbert C. Cress** named works manager. **Edgar M. Elliott** and **Frank R. Nesbitt** appointed senior marketing representatives.

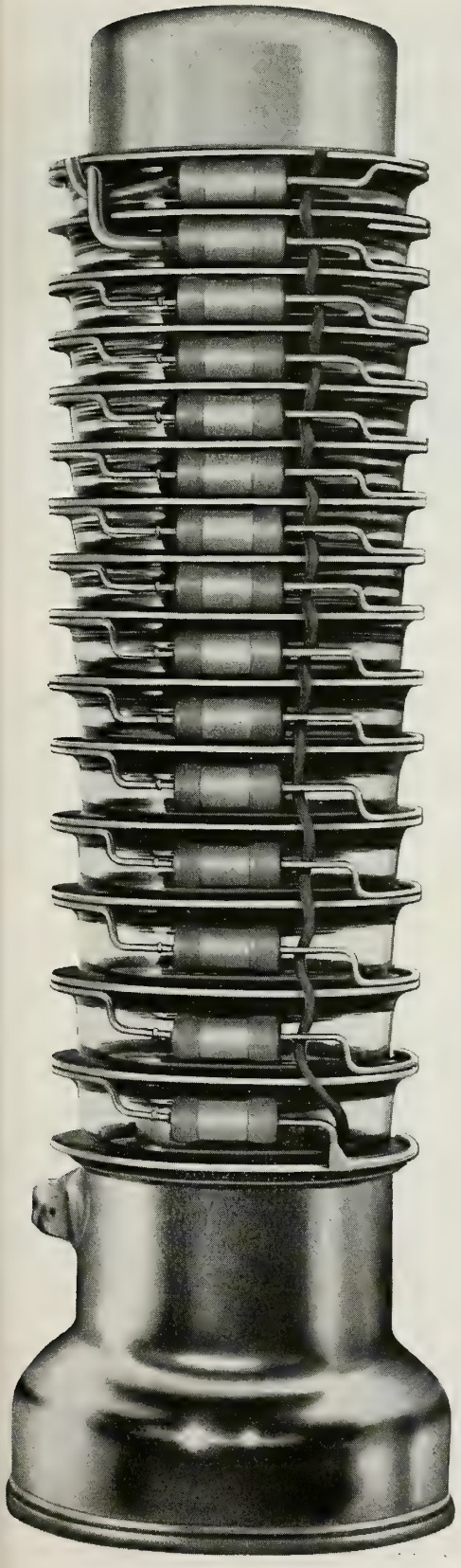
**Bernard Hathaway:** Appointed director of manufacturing for Electronic Memories, Inc., Los Angeles.

**James S. Farrior:** Named director of the Research and Engineering Center to be established by Lockheed Missiles & Space Co. at Huntsville, Ala.

**Robert E. Boak:** Named manager of industrial commodities for the Industrial and Marine Div. of Walter Kidde & Co., Inc., Belleville, N. J.

**Eugene J. Finn:** Appointed vice president-aeronautical marketing at the Firewel Co., Inc., Buffalo, N.Y.

**R. A. Williams:** Named assistant to the director of engineering at Philco Corp.'s Scientific Laboratory, Lansdale, Pa. **Dr. C. G. Thornton** named manager of the Advanced Solid-State Development Dept. and **Charles D. Simmons** named manager of the Microelectronics Dept. **Charles Gray** appointed manager of Commercial Engineering Dept.; **James D. McCotter** named manager of the Semiconductor Product Development Dept.; **Robert C. Musa** named manager of the Chemistry and Metallurgy Dept.; **Charles B. Tague** named manager of the Pre-Production Engineering Dept. and **W. J. Snyder** appointed manager of the Cathode Ray Tube Engineering Dept.



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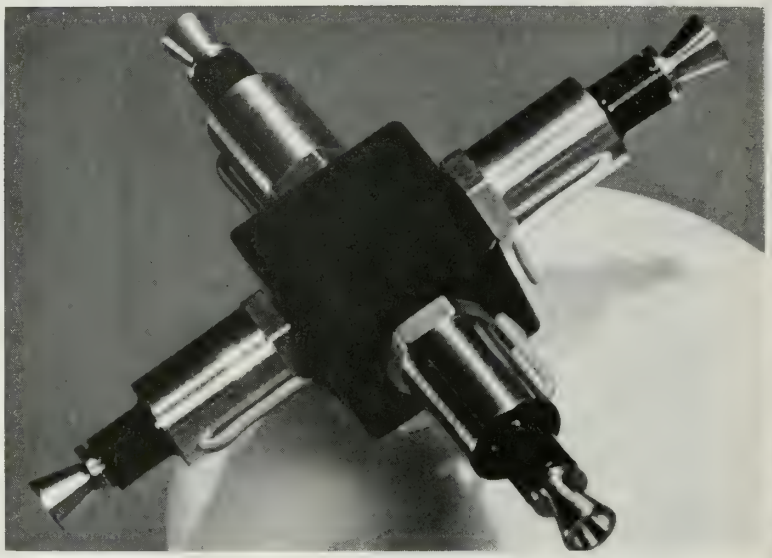
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## New Product of the Week:

## Subliming Solid Microrocket

A small attitude-control rocket based on a new solid-propellant formulation, which is stored as a solid but changes to gas as needed for pulse production, is available from Rocket Research Corp. No chemical reaction is involved, avoiding problems associated with ignition and combustion. Thrust levels range from 10 lbs. to very low values. The Model μR-10-4SS has a thrust of 0.0001 lbs. per nozzle, a total impulse of 170 lb.-sec., and weighs 2.7 lbs. loaded, 0.4 lbs. empty. A 4-in. spherical tank holds enough propellant to provide a year's control for a 5-ft. satellite.

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### Miniature Couplings

Power Instruments Inc. has developed coupling and collet sets which provide immediate test connections for commonly used shafts between 1/16-in. and ⅜-in. dia. for speeds up to 30,000 rpm.

Set No. 808 has two center couplings with 6 pairs of hardener aluminum end fitting collets for 1/16, 3/32, ⅛, 5/32, 3/6, and ¼-in. dia. shafts. A very flexible bellows center is used for torques below 140 gm-cm. A subminiature universal ball joint, used for higher torques, is believed to be the world's smallest. Set No. 808 is used for very small servos and synchros and delicate torque tests for speeds to 25,000 rpm.

Circle No. 226 on Subscriber Service Card

### Zener Diode Series

Dickson Electronics Corp. is marketing two zener diode series rated at 250 and 400 mw in hermetically sealed glass packages. Both series cover preferred voltages in a range of 6.8 to 200 volts with tolerances of 5%, 10% or 20%. All units contain single P-N junctions formed by carefully controlled diffusion at 1300°C of phosphorus into boron-doped silicon. In normal zener usage these junctions are biased in the reverse direction (cathode positive, anode negative.) This diffused junction provides a surge-current-to-leakage-current ratio substantially greater than has been achieved with tiny alloyed junctions.

Circle No. 227 on Subscriber Service Card

### Sweep Frequency Generator

A sweep generator with the electrical performance of a laboratory standard signal generator is available from General Radio Co. The type 1025-A covers frequencies from 800 kc to 240 mc to 10 ranges, plus bandspread ranges from 400 to 500 kc and 10.4 to 11 mc. Other ranges can be substituted in place of one or more of the standard ranges.

In sweep operation, the selected frequency range is swept from 10w- to high-frequency end in 22.2 milliseconds, 20 times per second. The output is blanked during the return sweep. A

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synchronized sawtooth sweep voltage for oscilloscope-display deflection is adjustable up to 100 volts peak-to-peak, and the starting point of the display sweep is also adjustable. An adjustable triangular marker provides not only frequency calibration of the display, but amplitude calibration as well, from 30 millivolts to 100 volts.

Circle No. 228 on Subscriber Service Card

## GSE Power Supply

A silicon-powered rectifier type d-c power supply capable of providing 15-35 volts d-c at 0-200 amperes d-c is available from Perkin Electronics Corp. The unit has a specially designed transistorized amplifier to provide ±6 volts, dynamic load regulation and adjustable recovery time from 20 and not to exceed 100 milliseconds.

The unit provides a static line and load regulation of ±0.5%, and ripple is 1% rms maximum over the entire output voltage range. A special feature of this power supply is its design to permit any combination of two of the same power supplies to operate in parallel in conjunction with two floating batteries, also operated in parallel.

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# new literature

REINFORCED PLASTIC MATERIALS—A complete listing in tabular form of all Poly-Preg reinforced plastic materials manufactured by U.S. Polymeric Chemicals, Inc. is available from the firm. This one-piece, file-type folder covers 29 different grades together with their commercial form, physical characteristics, resin, molding properties and typical end uses.

Circle No. 200 on Subscriber Service Card

SUBMINIATURE TRIMMING POTENTIOMETERS—Published by Daystrom, Inc., a technical data sheet on Daystrom 255 Series Squaretrim® subminiature trimming potentiometers provides complete specifications covering these ⅜-in. square adjustable units. With a range of 10 ohms to 50 kilohms, operating temperature range of −55 to 175°C, a power rating of 1 watt in still air and meeting or exceeding all applicable MIL-specs, the side-pin, potentiometers in the Daystrom Squaretrim 255 Series are used for the delicate adjustment of computer, control telemetering, missile and other critical circuits.

Circle No. 201 on Subscriber Service Card

SPDT COAXIAL RF SWITCHES—Quantatron, Inc. has announced the publication of a two-page, two-color technical specification sheet describing the company's SPDT Coaxial RF Switch Series SA-90. Series consists of small, lightweight, remotely-controlled coaxial switches. They cover the frequency range from d-c to 5 Gc. Outstanding features of the switches are described in detail, including their 3-ounce weight, 7 millisecond switching time, and fail-safe operation. The data sheet also lists applications and mechanical characteristics in addition to full 1 RF performance specifications.

Circle No. 202 on Subscriber Service Card

DIGITAL BUILDING BLOCKS—A complete catalog of data sheets on a full line of standard digital printed-circuit cards has been issued by Dynatronics, Inc. Designed especially for data processing applications, these cards provide all general logic functions in addition to special-purpose and system input-output interface requirements. The cards are grouped by function into three classes—Mc logic building blocks, special circuits and universal interface. Designed for high reliability under extreme environmental conditions, these units provide the design engineer with a family of versatile building blocks to design a complete digital system from a logic rather than an individual circuit level.

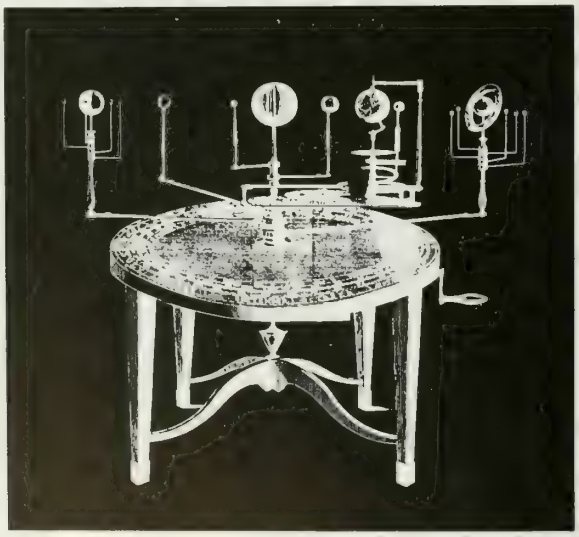
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THRUST MEASURING STANDS—Seven technical bulletins covering the latest Alinco single and multi-component thrust measuring stands is available from Allegany Instrument Co., Div. of Textron Electronics, Inc. Designed to support rocket motors and to permit accurate measurements of thrust components developed during subsequent static firings, several of these stands feature in-place load cell calibration devices employing the deadweight-amplification beam principle.

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STRATOGLAS 600 SI—Product and technical bulletins are available from Air Logistics Corp. describing Stratoglas 600 SI, a reinforced plastic material, which offers an unprecedented combination of impact and structural strength, together with the low weight and excellent corrosion resistance of technical grade fiber glass materials. Stratoglas 600 SI is being introduced, in sheet form, as the lining of cargo compartments on the Boeing Model 727 and other jet aircraft. However, the unique structural properties of the material, and the fact that it is also available in special molded shapes, suggest that Stratoglas 600 SI can also provide important weight and cost reductions in missile and space vehicle applications.

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### DECEMBER

**Structural Dynamics Under High-Impulse Loading Symposium, sponsored by AFOSR (Mechanics Div.) and Aeronautical Systems Div., Wright-Patterson AFB,** Ohio, Dec. 17-18.

**International Arms Control Symposium, sponsored by University of Michigan and Bendix Systems Div.,** University of Michigan, Ann Arbor, Dec. 17-20.

**Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science,** Philadelphia, Dec. 26-31.

**American Astronautical Society Symposium on Scientific Satellites—Mission and Design,** Franklin Hall, Philadelphia, Dec. 27.

The seminar on Pricing and Negotiating Prime and Subcontracts and the Defense and Aerospace Industries, reported earlier in M/R as being scheduled for the Marriott Motor Hotel, Washington, D.C., Dec. 10-14, has been cancelled.

### JANUARY

**Millimeter and Submillimeter Conference, IRE,** Cherry Plaza Hotel, Orlando, Fla., Jan. 7-10.

**American Chemical Society National Meeting,** Cincinnati, Jan. 13-18.

**Automotive Engineering Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Jan. 14-18.

**Ninth Annual American Astronautical Society Meeting,** Statler Hilton Hotel, Los Angeles, Jan. 15-17.

**31st Annual Meeting, Institute of the Aerospace Sciences,** Hotel Astor, New York City, Jan. 21-23.

**43rd Annual Meeting, American Meteorological Society,** New York City, Jan. 21-24.

**Ninth National Symposium on Reliability and Quality Control,** Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

**Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn.,** International Inn, Washington, D. C., Jan. 28.

**Fourth Annual Solid-Propellant Rocket Conference, American Rocket Society,** Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

### FEBRUARY

**Symposium on Engineering for Major Scientific Programs,** Georgia Institute of Technology, Atlanta, Feb. 5-6.

**Electronic Sales-Marketing Assn., First Annual Convention,** Americana Hotel, New York City, Feb. 11-13.

**Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques,** UNESCO Building, Paris, Feb. 11-15.

**Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory,** Engineers Club, Dayton, Ohio, Feb. 12-13.


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# An Objective View

THE OTHER DAY, one of our junior staff members brought in the story of the man who crossed a tiger with a parrot. What did he get?

"I don't know, but when it talks, you listen."

So it is with the money men of this, or any other, industry. When they talk, you listen. The Investment Bankers Association of America at its recent convention took a close look at the missile/space industry. Its findings are of interest because the investment bankers can take a more objective view of events and prospects than can either government or the industry itself.

The IBA market forecast is encouraging. Prediction is for a constant $5-billion outlay for Air Force, Army and Navy missiles in the 1965-70 period.

During the same period, NASA expenditures are expected to climb gradually from about $6.25 billion to $7.25 billion.

Spending on military space systems will accelerate from about $4 billion in 1965 to $9.5 billion in 1970, in the view of the bankers.

The outlook thus is for a missile/space market of some $22 billion in 1970, with expenditures on the military space program exceeding those of the civilian space program.

This expression of confidence in the industry's future on the part of the investment bankers also bodes well for a healthy financial market for industry firms during this period.

Part of this confidence results from the excellent past performance of the industry. The bankers say:

"Companies in the aerospace industry have on the whole done an extraordinary job of changing over from a business characterized by large production runs to one increasingly dominated by research, development and limited production quantities. They have displayed considerable farsightedness and ingenuity in adapting to an environment of rapid technological change and in providing the management techniques to harness the technological upsurge."

IBA also is encouraged by the fact that top management of both NASA and the Dept. of Defense has expressed determination to preserve a free industrial society. But the association sees some danger signs:

"There is almost a built-in tendency to regard defense industry as another extension of the government. It is understandable that many conscientious officers and officials, faced with the responsibility of administering large defense contracts and the ever-present duty to hold costs down, should tend to extend their concern into areas normally reserved for industrial management. Unfortunately, some of these administrators seem to feel it is also their duty to hold industry profits to a minimum."

IBA warns that the trend, if allowed to go unchecked, could end in the disappearance of the free enterprise system from this part of the economy. The association also warns that too narrow profit margins could impair the ability of the industry to support original, company-financed research and development.

Industry leaders have been calling attention to these dangers for a number of years. We hope the Administration will pay due regard to this note of alarm from more independent observers—observers whose confidence must be maintained if the industry is to remain financially healthy.

The bankers draw attention to two developments in this connection, one favorable, one unfavorable:

- Wider use of the incentive contract. This is regarded by IBA as improving the free enterprise aspects of defense contracting. "Wider use of the incentive contract would be one step toward allowing defense industry to function in a free environment more nearly comparable to that enjoyed by other American industries," its report says.
- Renegotiation. "The company which has taken a proper business risk and earned the fair rewards of good performance should not be subjected to a process of renegotiation based on the brilliance of hindsight," the association warns. IBA says the willingness of the contractor to assume risk must be matched by preservation of his right to make a profit.

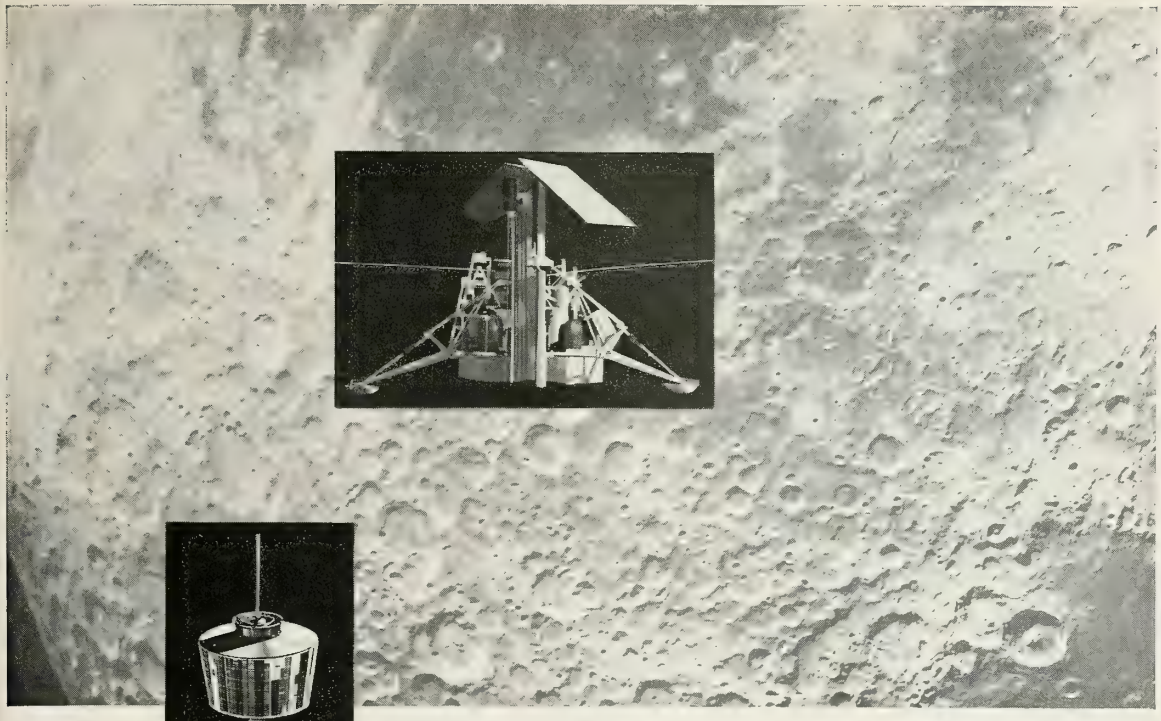
THESE THINGS have been said before, by this magazine and by others in the industry. But these are the observations of men who must balance the prospects of one industry against another in making financial decisions. They are not of this industry, but of many industries.

Therefore, their detection of "almost a built-in tendency to regard defense industry as another extension of government" carries considerable significance. They also point out the consequences if this tendency continues to be ignored.

The nation cannot afford to tolerate the risk of over-management by government agencies, nor continue to ask survival on profits too marginal for industry health.

The investment bankers have pointed to the substantial growth potential of this industry; they also have indicated danger areas which if not treated can stunt that growth. We note with high regard these views of the money men—and fervently hope that when they talk, somebody listens.

**William J. Coughlin**





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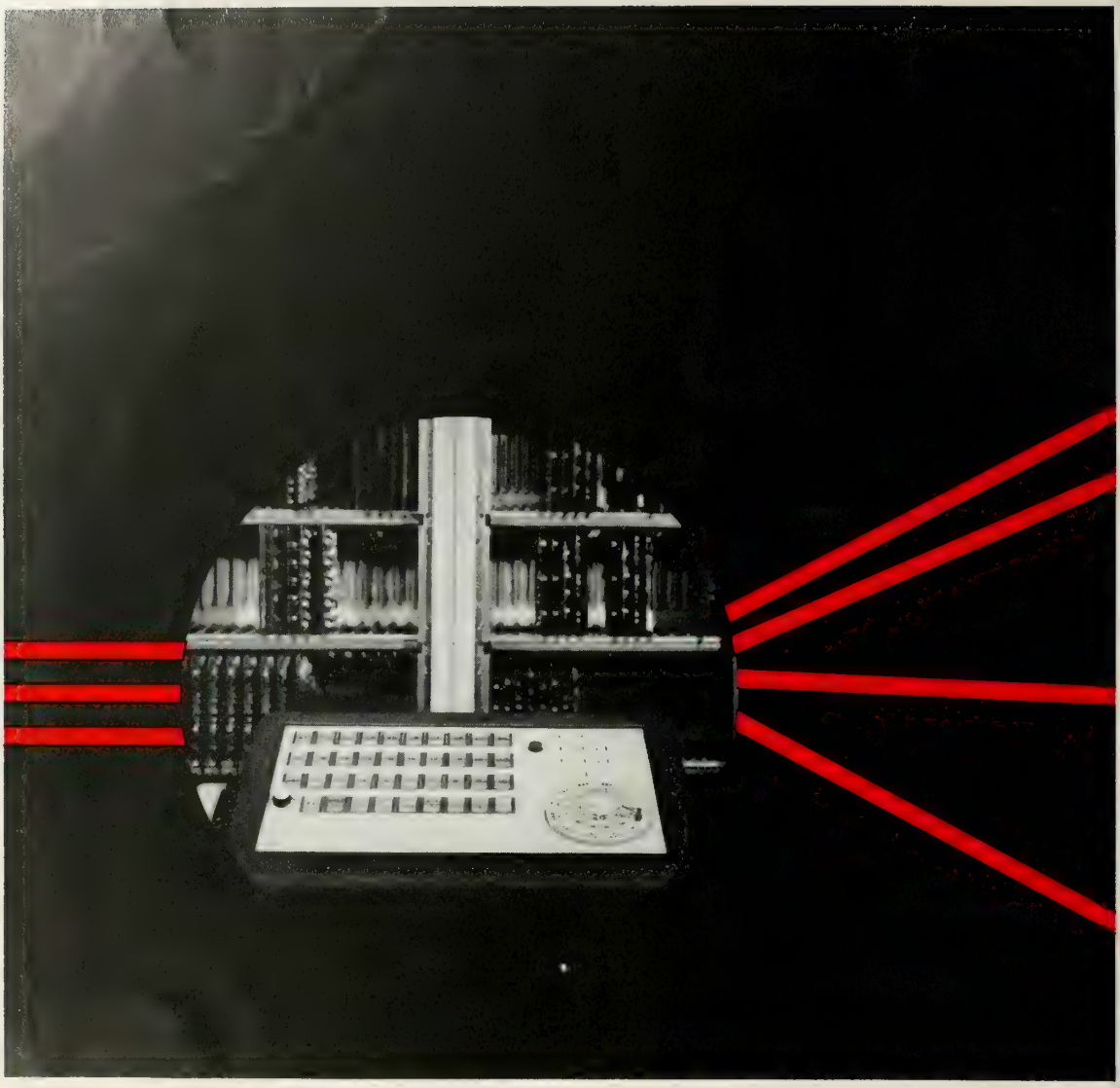
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# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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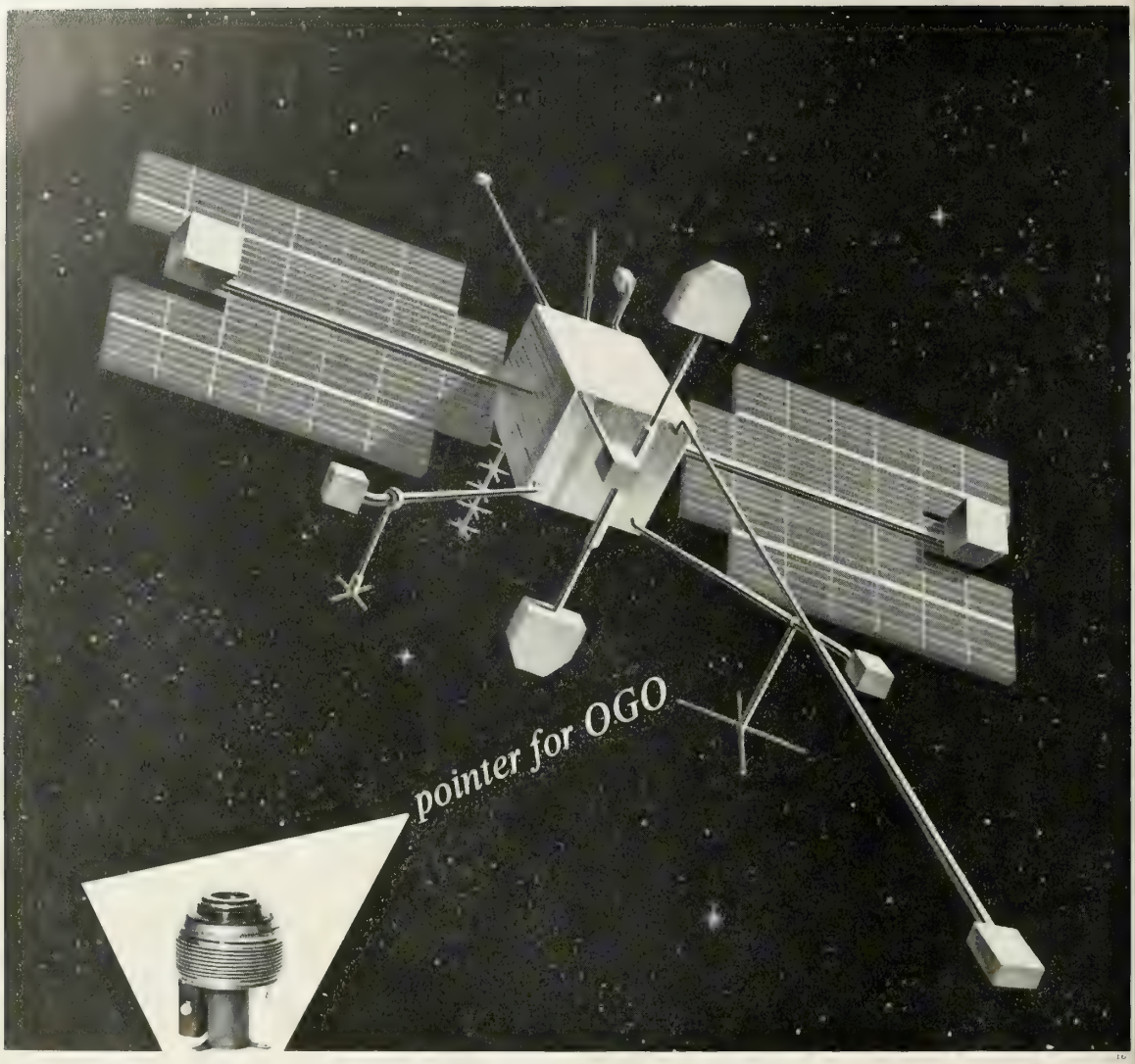


*Antenna on First Satellite Communications Ship*

Minuteman Operational at Malmstrom . .

NASA Sees Swelling Need for SNAP . . . .

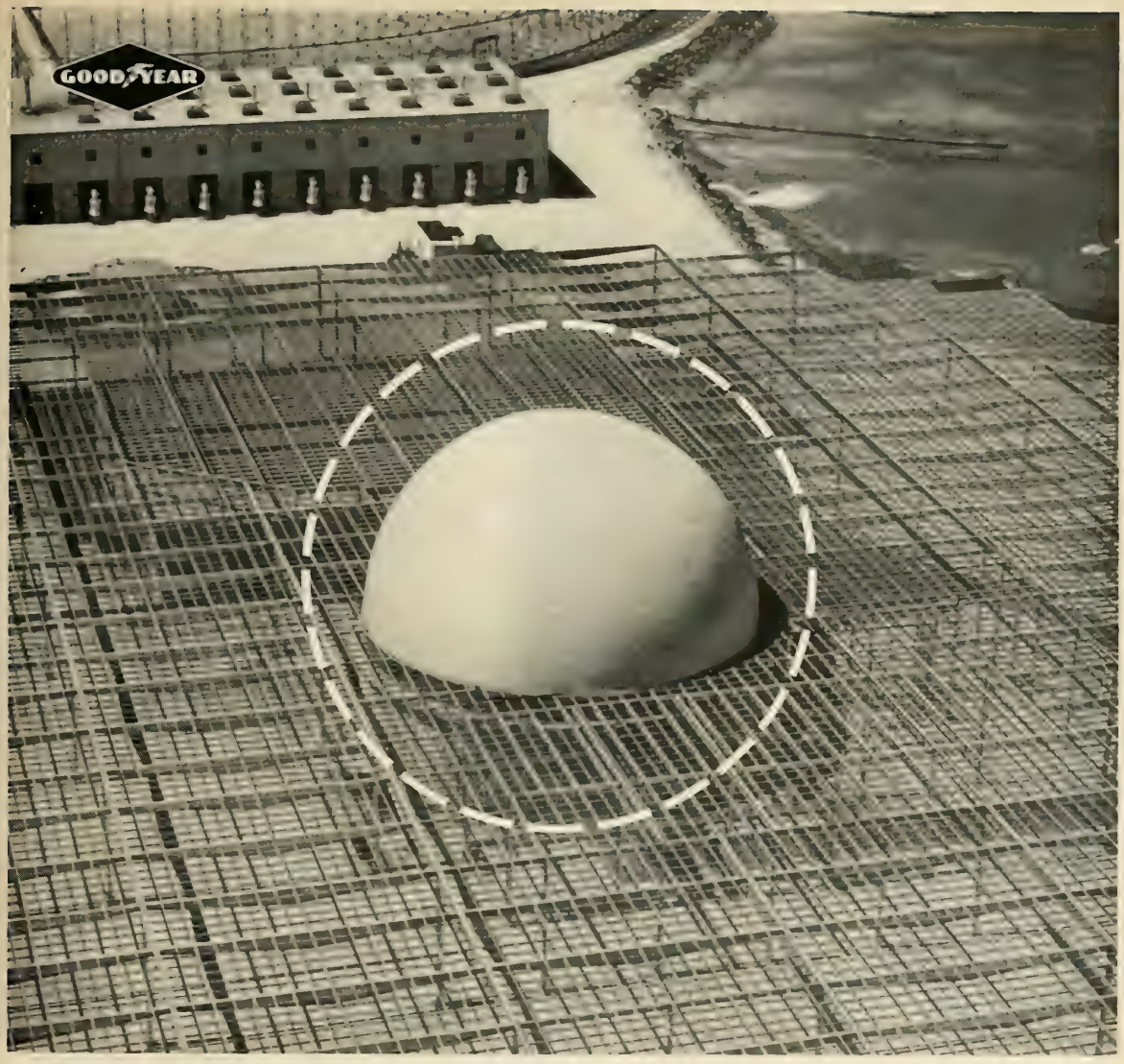
Army Satellites to Enhance Mapping. . . .




Once in orbit, OGO (NASA's Orbiting Geophysical Observatory) must orient scientific equipment in three directions. Some of its experimental packages must line up perpendicular to the sun's rays. Other experiments must turn to face the earth. Another group must seek a line parallel to OGO's own orbital plane. STL engineers and scientists have produced a hermetically sealed drive mechanism to help solve these orientation requirements. Two mechanisms are used in OGO's attitude control system. One rotates solar arrays in continuous orientation with the sun; a second keeps experiment packages fixed in desired position with respect to the orbital plane. The drive mechanism (shown above) is hermetically sealed to permit use of a conventional high-speed servo-motor without the usual problems of gear lubrication. It does its work by wabble or twist motion at a rate of one degree per second with a final gear reduction of about 24,000 to 1. STL's many projects include building OGO spacecraft for NASA's Goddard Space Flight Center, building spacecraft for Air Force-ARPA, and continuing Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in fields such as: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, One Space Park, Dept. B-14, Redondo Beach, California or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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Data provided by this antenna permitted computers to plot an intercept course for Nike Zeus, the Army's anti-missile missile system, which recently demonstrated the first successful intercept of an Atlas-boosted ICBM target vehicle.

This radar antenna measures 100 feet in diameter and contains tens of thousands of foamed plastic cubes embedded with metal particles. Yet for all its size and weight, the 1,800,000-pound lens and supporting structure rotate with the precision of a fine watch. It was designed and developed by GAC—Goodyear Aircraft Corporation—part of the nationwide industrial team brought together by Bell Telephone Laboratories and Western Electric to develop the Army's Nike Zeus system.

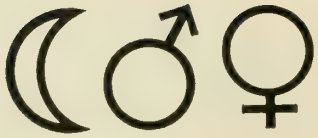
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BELL SYSTEM

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**A Bell Telephone System Company**

☾♂♀ Left to right, above, astronomical symbols for the Moon, Mars, and Venus.

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

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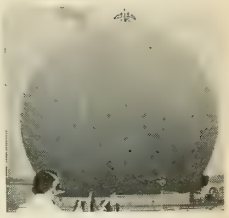
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## THE COVER

*This 53-ft. radome houses huge antenna aboard USNS Kingsport, world's first satellite communications ship, which went on duty Dec. 8. Systems Div. of Bendix Corp. is prime contractor to Navy for shipboard communications equipment.*

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† U.S. Reg. Pdg.

## Reliability Campaign

*To the Editor:*

Your Oct. 29 editorial, "Responsibility in Crisis," reflects a continuing laudable effort on the part of M/R to call attention to the important issues of our national defense with force, clarity and solid common sense.

We agree that the present world situation requires the utmost in reliability of the weapons we produce and that "nothing less than 100% performance is acceptable."

In referring to the *Bullpup* missile, you asked whether Martin (for example) has done everything possible to assure this kind of performance. Our answer to that question is that we are certainly trying, and have taken many positive actions in our efforts to achieve a high degree of reliability in all of our programs.

Most recently, we have started a Zero Defects program which is directed at improving the personal performance of every one of our plant's 10,000 workers. The purpose of this Zero Defects program is to motivate our employees to have a constant, conscious desire to try to do every job right the first time. Our success—through this program—in preventing defects has been beyond our expectations.

Here are just some of the results:

Entire *Pershing* ground support sets have been delivered to the Army without defects in either hardware or documentation.

Overall plant reject (defective hardware and documentation) rate has dropped 25% as compared with the same period in 1961.

Scrap cost percentages have been reduced 40% as compared with the same period in 1961.

The Zero Defects program has caught on with many of our vendors and subcontractors. As an example, the Dev-Tek Corporation of Orlando has delivered, since May of this year, more than 32,500 printed circuit boards without a reject. The fact that we are being swamped with requests from industry and military organizations throughout the nation for information on Zero Defects is another indication of the interest this effort has generated.

Your editorial neatly phrased the sentiments of Martin when it stated: "Nothing less than full effort is acceptable to the nation." We subscribe to this completely, and want to assure you that every effort possible is being made to provide our nation with the most reliable weapon systems in the world.

J. F. Halpin
Director, Quality Division
Martin Company
Orlando, Fla.

## In Defense of Meetings

*To the Editor:*

For some time now I have watched the barrage of opinion against the number and quality of technical meetings, most of which criticisms have been out of balance and lacked recognition of the main purposes of attending meetings.

A technical meeting is the only occasion which forces some of us to take the time to hear and recognize what is going on outside a specialized sphere of work which is limited simply by the fact that you as a person or company are isolated from the rest of the field. Can anyone visualize a responsible person being able to otherwise isolate himself from the daily grind for four days, let's say? Of course not.

I have found by attending meetings that there has yet to be an occasion on which I did not come back with a gold nugget of value—in some new technique, idea or understanding new acquaintance. It was at such an occasion, for example, that I finally recognized an Air Force captain's needs for help on a major technical problem which subsequently resulted in an RFP of technical and monetary significance.

At times there simply is no other way in which you can hear the policies of, or meet, responsible people. Even if an invitation were extended, the money and the time required for individual appointments would be far in excess of that required for meetings.

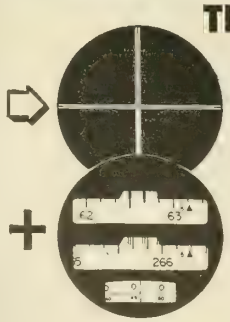
As long as statistical distribution exists, the quality of material presented at meetings will also vary. That is not to say that nothing can be done to improve the level of papers: the technical level is clearly the responsibility of the review committee, *as should be the quality of presentation*. The technical societies are surely not unaware of audiovisual media technique. A compulsory review of this phase would do much to raise the general acceptability of papers. The horrors committed upon audiences by accomplished scientific workers who are unaccomplished speakers are well known to all of us.

The "politicking" phase of meetings is sometimes also labeled objectionable. This is a legitimate, inescapable, valuable and desirable part of meetings. We are all individuals, and our personal progress is foremost. The opportunity for high professional association is what a company implicitly promises you—and what you as a member of the technical community are entitled to.

Finally, it is easy, if a company wishes, to check for value received. How many people on decision-making levels request, get or use written or oral trip reports or briefings? You can easily tell if you are getting your money's worth in reasonably tangible terms.

William Nagy
Seattle, Wash.


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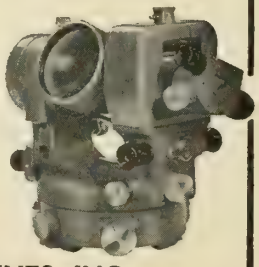


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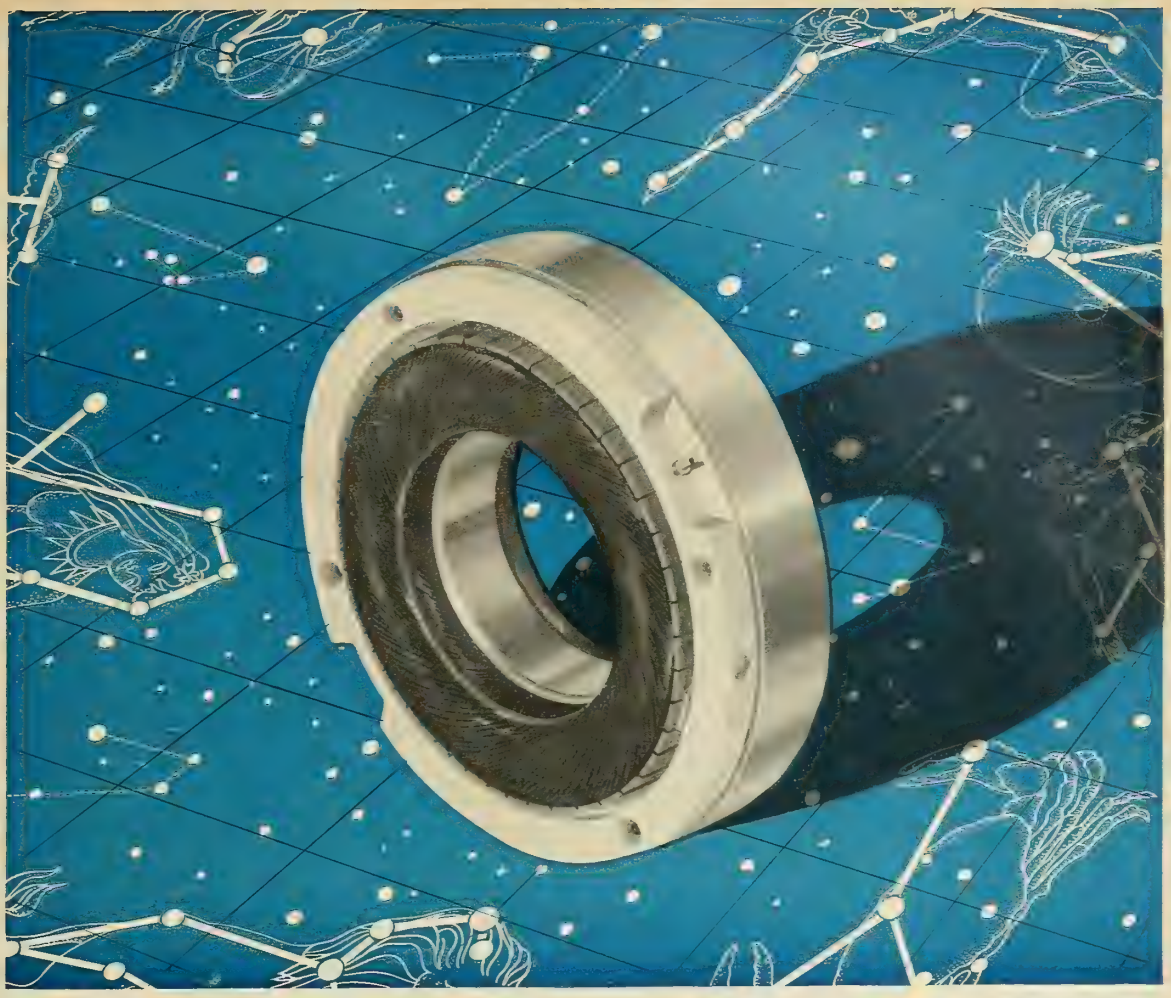


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# **Wanted:** Down-to-earth jobs for space-tested gearless torquers!

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# All Titan I's are operational

The entire force of Titan I intercontinental ballistic missiles is now operational. Six squadrons.

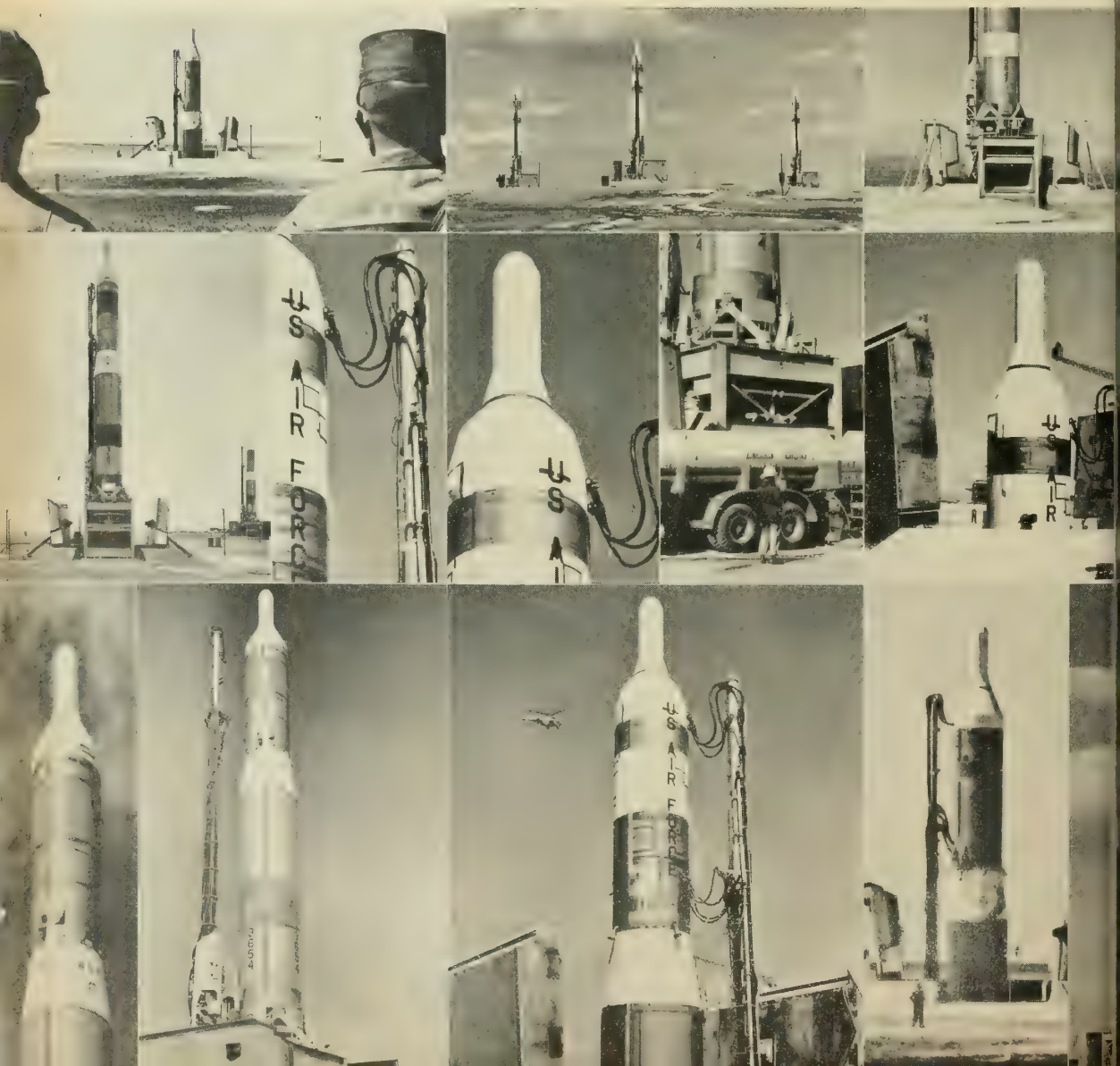
This achievement met a schedule laid down by the Air Force in 1959, calling on Martin Company to design, fabricate, test and deliver a reliable, operational Titan system.

Martin was also called upon to manage the simultaneous development and completion of steel and concrete underground silos to protect the missiles and hold them ready for firing against targets more than 6,300 statute miles away.

The missiles were ready and this most complex and difficult construction project in history was finished in late summer, 1962—as scheduled.

Already well on the way toward completion and operational status are six more hard-based squadrons for Titan II, more powerful, faster-reacting Air Force ICBM.

**MARTIN** MARTIN MARIETTA



# The Countdown

## WASHINGTON

### New FABMDS Program Is Okayed

Pentagon go-ahead for a new Field Army Ballistic Missile Defense System (AADS-70) calls for $1-2 million to be spent on program definition in the Fiscal '64 budget. The Army will go out to industry for proposals in mid-January in an open competition. Bids will be due 60 days later and program definition awards are to be made in May to two or more contractors.

### Saturn-Agena Launch Vehicle Studied

A formal group has been established within NASA to study a possible *Saturn-Agena* launch vehicle as backup to the delay-plagued *Centaur* program. Officials are hoping such a step won't be necessary, since payload capability of 2000 lbs. is considered far too small.

### New Warheads for Polaris and Minuteman

One of the least-discussed improvements attainable in warhead effectiveness is that of using more than one re-entry body per missile to improve target coverage. Although this decreases warhead yield for each re-entry body, overall effectiveness on target is increased. Both Navy and Air Force are reported to be working on this concept for advanced versions of *Polaris* and *Minuteman*.

### Surveyor Tests to Start at Holloman

NASA plans to test the *Surveyor* spacecraft's lunar soft-landing capability at Holloman AFB early next year. Space agency scientists now are committed to a 2100-lb. spacecraft in the belief that further scaling-down would negate most of its scientific value.

### Errant Polaris Leads to Probe

A full-scale re-examination of destruct package requirements for solid-fuel missiles is expected as a result of fears aroused by a runaway *Polaris A-3* on Dec. 7. The missile failed to destroy itself completely when the command destruct signal was given. A large section veered off on a northeasterly course and fell in the Atlantic 150 miles east of Savannah, Ga. Only chance prevented it from falling inland.

### Minuteman Was Ready for Cuba

Although it was not announced at the time, one 10-missile *Minuteman* flight at Malmstrom AFB was turned over to SAC during the Cuban crisis. Official operational turn-over was last week (see p. 14). But contractors, laborers and military personnel worked around the clock to get the complex ready for action during the tense week in October when it appeared the ICBM's might be needed. Air Force spokesmen are high in praise of the cooperation received. Some contractors are refusing to bill AF for the extra effort.

### Mercury Control to Be Expanded

The *Mercury* control center at Cape Canaveral will be expanded for the *Gemini* and *Apollo* programs. The Army Corps of Engineers has set Jan. 4 for a bid opening on a 7200-ft. expansion of the center. Alterations, which will cost $300,000, are to be completed on a rush basis by June 15.

### Pershing Mobility Tests Under Way

A Chinook helicopter is being used at McCoy AFB to flight-test mobility of the *Pershing* missile and other components of the weapon system. The missile system will be airlifted by the Chinook to other Florida areas.

### Polaris Achieves High Readiness Record

The Navy says all 16 missiles on each *Polaris* submarine have been ready to fire 95% of the time while the sub is on station. Fifteen of the 16 missiles have been ready to fire an impressive 99% of the time. The figures were released by Navy Secretary Fred Korth.

## INDUSTRY

### Need Seen for 20 to 40 Aerospace Trainers

Competition between Lockheed and Northrop for a contract to build 20 to 40 rocket-powered aerospace trainers is becoming hotter. Lockheed is offering an all-rocket version of the three turbojet-and-rocket NF-104 aerospace trainers, which already are being modified. Northrop proposal, said to have the inside track with Col. Charles Yeager, boss of the USAF Aerospace Research Pilot School, is a version of the two-place T-38.

### Parallel Propulsion Development for LEM

North American Aviation's Rocketdyne Div. and Thiokol's Reaction Motors Div. are emerging as favorites in a parallel development effort for the lunar descent propulsion system for the Lunar Excursion Module. Selection of two firms for the early development phase was said to have been favored by NASA, with Grumman preferring a single contractor. Reaction control engine development is expected to go to Marquardt, with Bell Aerospace the favorite to win the lunar takeoff engine competition.

### AF Rocket Center Shifts to Research Div.

Air Force's 6593rd Test Group (Dev.) at Edwards AFB has been transferred from Space Systems Div. to the newly formed Research and Technology Div. headquartered at Bolling Field in Washington, D.C. The organization will be re-named the Air Force Rocket Propulsion Laboratory. Six other AF Systems Command laboratories are in the R&T division structure, but the Edwards facility will be the only one conducting rocket research programs.

## INTERNATIONAL

### New Swedish Missile Development Set

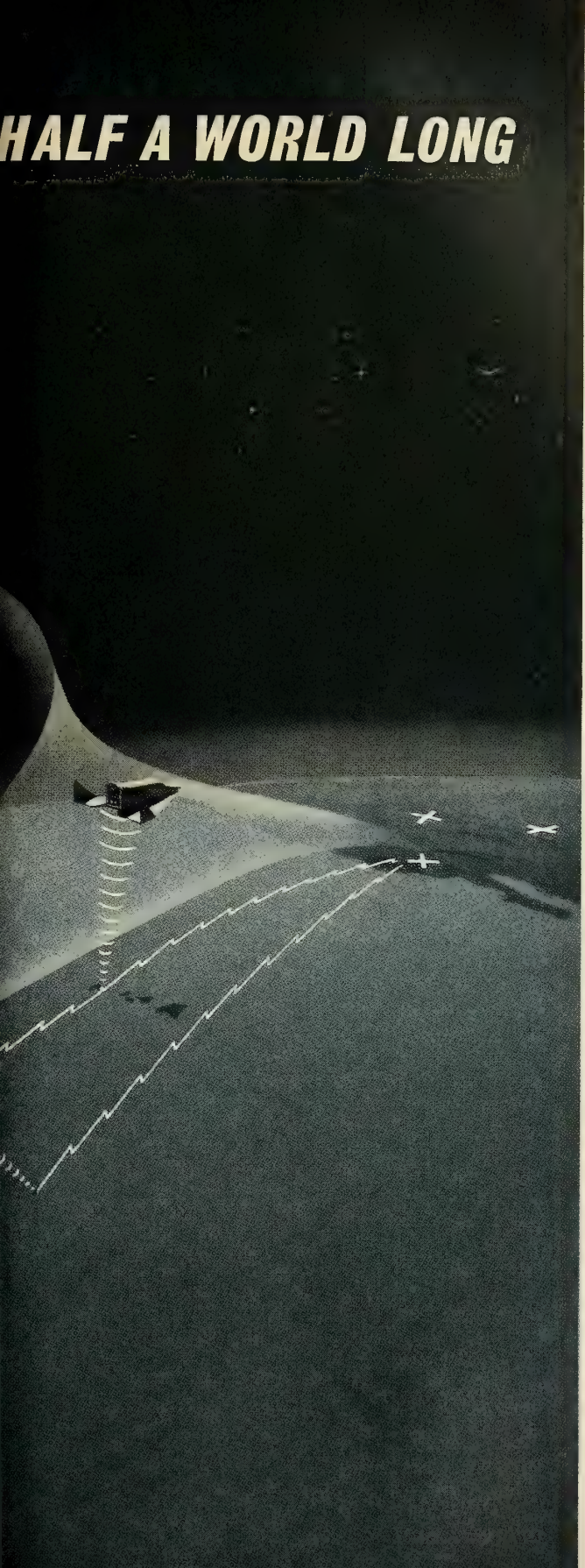
Saab will develop a new air-to-surface missile as primary armament for the new Viggen fighter to be built for the Swedish Air Force. Saab is prime contractor for the entire system, designated System 37. A modernized version of the Robot 304 air-to-sea missile which now is standard armament on the A-32 also will be developed for Viggen.

### French Space Budget Doubles

The French budget for 1963 earmarks a total of some $32 million for space research. This is double the 1962 budget. The program includes $1 million for a research program in cooperation with NASA.

# TRAFFIC PATTERN






# The Problem . . . Space Vehicle Recovery

How do you guide a manned, maneuverable re-entry vehicle to a routine landing . . . from 200 miles up, 10,000 miles out?

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For over three years a Raytheon team led by R. L. Schroeder and John Zvara has been investigating these and other recovery problems. Primary emphasis has been placed on NASA's Gemini and Apollo, USAF's X-20 (Dyna-Soar), SLOMAR, and recoverable booster programs.

Result: A unique conceptual techniques capability. Understanding of what must be done to make a Recovery Control System work. Allied experience in real-time data processing and display, communications, and hypersonic vehicle guidance.

Schroeder, Zvara and other Raytheon scientists have published many technical articles on recovery control requirements, problems and concepts. We have collected a number of these and bound them under a single cover. If you would like a copy of this comprehensive document on system requirements for manned space vehicle recovery, write: M. B. Curran, Dept. GM 13-6A, Raytheon Co., Lexington 73, Massachusetts.



Raytheon's John Zvara (left) and R. L. Schroeder

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# The Missile/Space

## Skybolt Fate Uncertain

No final decision on cancellation of the *Skybolt* air-launched ballistic missile will be made until after President Kennedy meets with British Prime Minister Harold McMillan in Bermuda this week.

While noting that Britain has an important equity in the *Skybolt,* the President last week questioned the value of the missile system in light of its five consecutive test failures, the $500 million already spent through FY '63 for its development and the estimated $2.5 billion for the production and procurement of the system.

Even without *Skybolt,* the President said, the British would continue to play a significant role as a nuclear power.

Last week, British reaction to the U.S. Defense Department's decision to cancel the *Skybolt* program appeared to offer some indication that the U.S. decision was not irrevocable. Secretary of State Dean Rusk in a news conference said that *Skybolt's* future "is not yet settled."

However, Secretary of Defense McNamara's decision to cancel the program was based on a review of the entire program, its operational objectives and cost/effectiveness of the system against anticipated Soviet threat.

On the basis of this review, according to one DOD official, it is apparent that the 1000-mile suppressive-fire missile will be obsolete before it becomes operational.

Hardest hit by cancellation of *Skybolt* would be Douglas Aircraft Co.'s Missiles and Space Div. in Santa Monica, Calif. Company officials estimate that one out of every six employees, about 17% of its total work force, are engaged in the *Skybolt* program. Also hard hit by cessation of the program would be Nortronics Div. of Northrop Corp., guidance contractor; Aerojet-General Corp., propulsion contractor and General Electric Co., re-entry body contractor.

## NASA Sifts Mariner II Data

Useful results were expected by NASA officials from the Dec. 14 Venus fly-by of *Mariner II* despite spacecraft temperatures that averaged 20% higher than predicted levels.

The 447-lb. spacecraft was

launched by NASA Aug. 27. Its 109-day journey to Venus covered 182 million miles. During the long cruise, it set a long-distance communication record of 36 million miles and performed the first successful U.S. guidance maneuver in space.

*Mariner* carries six scientific experiments. Four of these—turned on two days after launch—provided invaluable information on magnetic fields, radiation and dust particles in space.

Its two most important experiments—a microwave radiometer and an infrared radiometer—were scheduled to scan the Venus surface and atmosphere for 42 minutes just before its closest approach to the planet. The experiments are designed to answer the age-old question of whether some form of life is possible on the planet.

Space agency officials estimated *Mariner* passed 21,000 miles from Venus at 3:01 p.m. EST Dec. 14.

## Relay, S-55 Ready To Go

Launch of an *S-55* micrometeoroid and a *Relay* communications satellite were scheduled for late last week by NASA. Earliest date for *Relay* was Dec. 13; for *S-55*, Dec. 14.

*Relay* was to go from Canaveral aboard a *Delta* booster, which had chalked up 13 straight successful flights.

RCA is prime contractor for the low-altitude active repeater satellite. If successful, it will be the first space-communication experiment to link three continents, North America, Europe and South America.

The *S-55* was due to be launched by a four-stage *Scout* booster from Wallops Island, Va. Its primary objective was to determine whether micrometeorites are hazardous to space vehicles. If a successful orbit is achieved, the satellite will be called *Explorer XVI* (see photos, p. 37).

## Shots of the Week

An Army *Nike-Zeus* antimissile missile successfully intercepted an *Atlas* target vehicle over Kwajalein Island, Dec. 12, the Defense Department announced last week. It was the second successful intercept announced by DOD; the first took place July 19.

Two Western Electric *Nike-Zeus* missiles were fired from Kwajalein, according to DOD. The first missile made the intercept while the second was destroyed after it veered off course.

The target vehicle had been launched from Vandenberg AFB, Calif. by a General Dynamics *Atlas D* ICBM fired by a SAC crew from the 576th Strategic Missile squadron. The launch was initially termed "a routine training" exercise by AF officials. The *Atlas* was programed for a flight of more than 5000 miles.

• Announcement of the operational status of the Boeing *Minuteman* at Malmstrom AFB, Mont. (see story p. 14) was dimmed somewhat when a *Minuteman* destroyed itself Dec. 10 after launch from Vandenberg AFB. No explanation as to why the solid-fueled ICBM "blew itself up" shortly after launch was immediately available.

• Martin's *Pershing,* the U.S. Army's solid-fueled replacement for *Redstone,* was successfully fired from Cape Canaveral Dec. 10. Test objectives included zig-zag maneuvers to test ability of the missile's guidance system to bring it back on course. All test objectives were fulfilled, Army officials said.

• A *Minuteman* ICBM carrying an improved Avco Mark 11 re-entry body was successfully fired from a Cape Canaveral silo Dec. 7. The 3500-mile test flight achieved all its objectives, AF officials said.

• An attempt to fire a Martin *Titan II* ICBM on the longest flight of the year for a U.S. missile failed Dec. 6 when the missile exploded two minutes after launch from Cape Canaveral. The flight had been programed for 8000 miles down the Atlantic Missile Range. It marked the first time in eight flight tests that the *Titan II* had blown up after launch.

• The Navy's Lockheed *Polaris A-3* missile encountered its sixth straight failure Dec. 6 when its troublesome second stage exploded shortly after ignition. Five of the six *A-3* failures have been malfunctions of the second stage. Debris from the destroyed missile fell into the Atlantic Ocean off the Georgia coast.

• An Aerojet-General *Aerobee 150A* sounding rocket carrying a 186-lb. scientific payload for the Australian government "malfunctioned and the payload did not reach the intended altitude" in a Dec. 11 firing from Wallops Island, Va. The experiments were to have measured VLF radio waves in the ionosphere.

• A Martin *Mace* was successfully fired from Cape Canaveral Dec. 11 in a test of system performance and crew reliability.

## Rover Insulation Failed

Disassembly of the Kiwi B-4A reactor has shown failure of thermal insulation surrounding the core, apparently resulting from mechanical stress early in the test. Harold B. Finger, manager of the Space Nuclear Propulsion Office, said there were cracks appearing in the thermal structure remaining in the reactor, but effects on the rest of the unit were still undetermined.

Next test, now slated for early next year, will probably feature a modified thermal insulation design.

The flashes of light seen in the Kiwi B-4A exhaust stream are believed to have been particles of thermal insulation stripped from the core. Neither planned temperature nor planned power were achieved during the 260-second run, but the causes of the premature shutdown indicate that basic design of the reactor may still serve as a prototype for the *NERVA* program.

## AEC Wants Georgia Lab

The Atomic Energy Commission has requested that the Georgia Nuclear Laboratory at Dawsonville be transferred to the AEC as a support facility for NASA's *RIFT* nuclear rocket stage.

The laboratory, a large radiation test facility, is located about 45 miles northeast of Atlanta. The AEC made the request of the General Services Administration Nov. 23 to insure continuing availability of a facility suitable for the irradiation testing of large space-vehicle components.

## NAA Sets Sales/Profit Marks

North American Aviation, Inc. last week reported it ran up record sales and net profits in Fiscal 1962.

Sales and other income totalled $1,633,675,000 and net earnings added up to $34,557,000, or $4.15 per share. It was the fourth time in the last six years that company sales have topped $1 billion.

*In Malmstrom silos . . .*

# Minuteman Goes Operational

***ICBM activation slated to take place at four other SAC bases; security measures are elaborate***

**by Richard van Osten**

AN AVERAGE of about one Boeing *Minuteman* ICBM per day will be turned over to Strategic Air Command launch crews during 1963—if the present rate of effort continues.

The first two 10-missile flights of the 10th Strategic Missile Squadron, 341st Strategic Missile Wing (SAC), at Malmstrom AFB, Great Falls, Mont., were officially declared operational in formal ceremonies last week. Balance of the 15-flight, three-squadron wing is expected to go operational in similar increments, with full-scale, 150-missile capability to be completed by late spring or early summer. Tapering off of work at Malmstrom will mesh closely with activation of initial Wing-II units at Ellsworth AFB, Rapid City, S.D.

Next in line are Wing III, Minot AFB, N.D.; Wing IV, Whiteman AFB, Mo.; and Wing V, Warren AFB, Wyoming. The Air Force has high hopes for more than the 800 *Minuteman* installations presently planned, but it has no firm commitments. Much depends upon what the Fiscal 1964 budget provides.

Air Force is studying two paths. One is replacement of early missiles with advanced versions—updating and improving capabilities. The second plan —indicated several months ago and still active—involves construction of new sites. Depending upon future funding, the final decision could take either route or a combination of both. Primary consideration is the financial and operational trade-off between missile retrofit and construction of additional sites.

• **Spartan setup** — Simplicity and compactness of the *Minuteman* system contrast sharply with the relatively complex, large-scale *Atlas* and *Titan* systems. The hardened launch control center (LCC) provides little more than move-around space for the missile combat crew commander and his deputy.

At Malmstrom, one LCC (there is one per 10-missile flight) is serving temporarily as a squadron command post. This throws a higher-than-normal load on the two-man crew. A tour of duty is 12 hours, but as more LCC's become operational, a 48-hour tour is likely.




*TRANSPORTER-erector at Malmstrom AFB in position to lower Minuteman into its silo.*

The crew commander's position has basic intersite communications and launch controls. To avoid inadvertent launch, the system includes—in addition to normal security measures, command coding and command verification —a firing arrangement under which both the commander and his deputy must turn two keys within about two and one-half seconds of each other. The keys are situated so that no one crew member can turn both within the required time period. In addition, launch requires verification and certain other cooperative procedures by at least one other LCC.

Primary launch panel for the commander has ten rows of ten lights each —one vertical row for each missile. From top to bottom, the lights indicate "strategic alert (green)—an all-systems go condition." Next is a red "fault" light, indicating a malfunction and a no-launch status for the particular missile. Next is a self-explaining "standby" light, followed by a "warhead alarm" light for a fault in that area. On down the panel are "armed," "launch commanded," "launch in process," "missile away," "outer security violated" and "inner security violated."

The last two lights are coupled to an audio signal. Outer security violation signals are sourced from four radar antennae at each launch facility (LF) —the missile silo and support building area. The radar is focused on the silo lid and access door. Any "object" in this area is immediately detected and the LCC alerted. The system is also equipped with a signal-generating system for self-check. Sensitivity is such that even a person approaching the silo by crawling under the surface of a heavy snow can be detected.

Inner security alarm is controlled by signal devices on the silo lid, the access door and the safe-type, below-grade access door to the LCC.

The deputy's position has duplicate communications gear, switches for selection of individual missiles to be launched, and a VRSA (voice reporting signal assembly) system, by which he may query any of the 10 silo positions for missile status. ⁂

***Boon for AEC program . . .***

# NASA Foresees Growing SNAP Needs

***1500% increase in radioisotopic units forecast by 1972; initial use seen in 1964***

**by Hal Taylor**

NASA HAS GIVEN the Atomic Energy Commission's SNAP program a shot in the arm by forecasting a 1500% increase in its needs for the nuclear power units by 1972.

Use of the radioisotopic units would not begin until 1964, when 200 watts would be required. The space agency tentatively expects that requirements then will jump to 1500 watts in 1968 and 3000 watts in 1972.

The official estimate was forwarded in a letter from NASA to the AEC early in November. The letter emphasized that the estimate was not a firm commitment, but the most educated forecast which could be made at this time.

It is almost certain, however, to serve as a basis for AEC program planning. The commission has little else to go on.

Capt. Robert Carpenter, of the AEC Division of Reactor Development, told MISSILES AND ROCKETS, "The letter was a kind of breakthrough."

"It is the first time," he said, "that any user agency has expressed an interest in using large quantities of isotopic units."

• **Unanswered questions**—The NASA estimate was prepared by Dr. Fred Shulman, chief of the agency's Nuclear Electrical Power Systems Office.

It is based on a long series of discussions and presentations to satellite and spacecraft program directors in the Office of Manned Space Flight, Space Sciences and Applications.

Shulman said that the degree to which the estimates eventually become firm requirements will depend upon many unanswered questions in both NASA spaceflight and AEC SNAP programs.

For example, Plutonium 238 fuel for a SNAP unit costs $44,000 a watt, about 22 times the cost of a comparable solar cell fuel system, which is now used in most NASA projects. Space agency officials also want more information on the "safety problems" involved in the use of SNAP units.

Another difficulty is the fact that most projects which could use nuclear power are just reaching the preliminary study and design stage. There is also a large segment of NASA scientists who feel that solar cells have proved their feasibility and should continue to be used.

Despite these problems, Shulman said, the letter was intended to serve as a guide for AEC officials in program planning. He added that NASA will update the estimate annually.

• **Advances**—Despite the lack of firm commitments, the letter has already resulted in new SNAP development steps. These include:

—NASA has asked AEC to study the feasibility of a SNAP unit to power *Interplanetary Monitoring Probes (IMP)*. Space agency officials have asked the commission to report its findings by mid-1963, when it is hoped a contractor can be selected. *IMP* will require a 40-to-50-watt power capacity, but the space agency is leaving to AEC the decision as to whether one or two units will be used. NASA expects to fly two or three of the probes per year in 1964-65.

—It is expected that AEC will establish a separate research and development project to study possible requirements for SNAP units in communication satellites. The power range mentioned by NASA officials is 165 to 250 watts. The unit could be used in either advanced low-altitude or high-altitude satellites. Officials of NASA's ComSat office have already been shown a tentative design.

—NASA has asked AEC to continue its work on a small unit for use in its *Surveyor* program. While the unit will definitely not be used for the first seven lunar soft-landing spacecraft, it may still play a role in the lunar orbiters planned for the program. Officials also feel that conditions on the lunar surface could rule out the use of solar cell power, making the use of nuclear units necessary.

In preparing its estimate of future needs, NASA did not attempt to break it down into number of units because of the many variables involved. Instead, the estimate was based on the best guess the agency can make now as to how many watts of power it will require from year to year. ⌗

## *NASA To Keep Agena in Gemini*

TOP SPACE AGENCY officials have rejected a proposal that the *Agena* target vehicle be dropped from the *Gemini* two-man spaceflight porgram.

The decision not to change the program's orbital rendezvous flights was made following meetings between officials of NASA headquarters and the Manned Spacecraft Center in Houston.

Reliable sources reported that only a final review by Associate Administrator Robert C. Seamans, Jr., is needed before the decision becomes final.

In another development affecting the *Agena* upper-stage program, NASA announced that it was transferring management responsibility of its *Atlas-Agena* and *Thor-Agena* launch vehicles from the Marshall Space Flight Center to the Lewis Research Center.

The announcement said the move will enable Marshall to concentrate on the *Saturn* and *Advanced Saturn* launch vehicles needed for the manned spaceflight program.

The suggestion to drop *Agena* from the *Gemini* program was made by the Systems Engineering group in the Office of Manned Space Flight. The group, under director Dr. Joseph Shea, called instead for the rendezvous docking experiment to be conducted with a small satellite to be launched piggyback on the *Gemini* spacecraft.

In disclosing rejection of the plan, a NASA official said that the switch would have created new technological problems for which the small amount of money saved would not have compensated.

*Cheaper than ANNA . . .*

# Army Satellites To Enhance Mapping

***Engineers at work on two types of piggyback units which would carry SECOR; details of SECOR system***

**by James Trainor**

THE ARMY CORPS of Engineers is developing two inexpensive piggyback satellites as part of a three-to-five-year program to tie existing geodetic datum planes into a single world-wide network.

The program is expected to reach its peak in about two and a half years and be completely phased out by the end of six years.

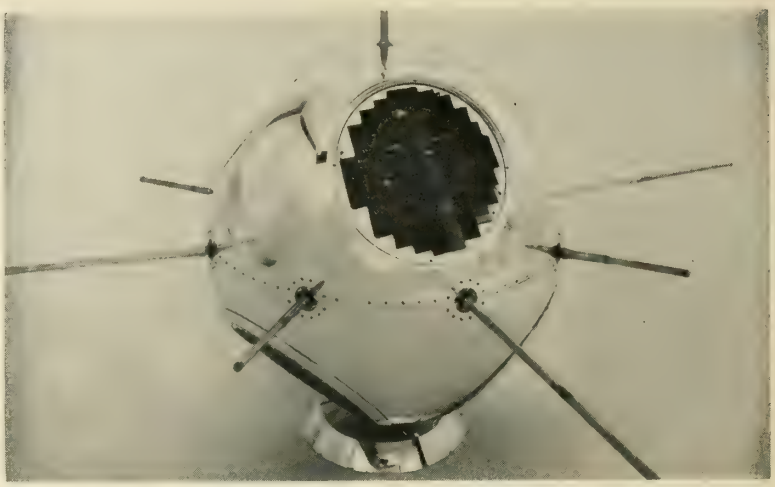
During that time, however, the Army expects to reduce the error in location of the world land masses from one mile for continental masses and 5-10 miles for smaller land masses, such as islands, to plus or minus 30 meters over a 1000-mile distance.

Using the 20-in.-dia. *Vanguard* shell and the SECOR radio-ranging unit, the Engineer Research and Development Laboratories at Fort Belvior, Va., have evolved what they call the "Type I" geodetic satellite (M/R, Feb. 6, 1961, p. 22). With the Type I vehicle, the geodetic satellite could be launched as part of a composite payload.

Cubic Corp. has already built and delivered four Type I satellites to the Army; a fifth was built by ITT with government-furnished equipment. One Type I satellite was carried as part of the *Composite I* payload—the abortive Navy attempt to launch five satellites with one booster on Jan. 24, 1962. Since the Army has one Type I prototype which is solely for test purposes, there are still three Type I vehicles on the shelf available for launch.

• **Next step**—The second satellite version—"Type II"—is based on the premise that "nose cone" space is at a premium, whereas space in other areas of a spacecraft is wasted and is usually taken up with ballast. Therefore, the Type II satellite will be rectangular in shape and have only a 9-in. depth, allowing it to be placed between the structural members and the skin of a spacecraft.

It would be particularly suitable, Army officials say, for the aft instrumentation rack of the *Agena D* spacecraft which, because of its presently little-known capacity, is being launched with much of its aft payload area vacant.



*TYPE I SECOR geodetic satellite utilizes 20-in. Vanguard shell shown here.*

Once in orbit, the Type II satellite is separated from the primary spacecraft by means of a spring.

The Type II vehicle is now in the preliminary design stage. Originally, the Army had planned to go out to industry for the Type II vehicle this year, but slippage of some 18 months in an Air Force program that would have carried the Type II has postponed RFP's until the beginning of FY '64.

Once the proposals are issued, however, the Army expects to have a prototype within 90 days of the contract award. The reason for the early delivery date, Army officials say, is that building the satellite is essentially only a packaging job—changing the mounting of the SECOR transponder from a center post in the Type I to edge-mounting in the rectangular Type II.

Depending on results of the Type I program and the *ANNA* follow-on program, the Army plans to procure a non-flying prototype and two flight versions of the Type II. Total cost of the Army program including ground stations and the two types of satellites is estimated at $6.5 million, with each satellite priced at approximately $150,000.

Although SECOR is one of the three major experiments aboard the *ANNA* satellite, the Army's limited funding, together with the uncertain nature of the follow-on *ANNA* program, has caused ERDL engineers to evolve the piggy-back satellite concept. At present, the Army pays about one-third of the launch vehicle and launch costs for the Navy-managed geodetic satellite program; the piggy-back approach would cut costs to those required for fabrication of the payload.

Army continuation in the *ANNA* program appears virtually certain, however, particularly if NASA funds the launch costs—a possibility now under discussion. Although not completely firmed up, the four-to-six-shot *ANNA* follow-on program would be under NASA's direction, with the Navy's Bureau of Weapons acting as the space agency's executive agent. The program would be designed to give a continuous flow of geodetic information starting with the first launch in December, 1963.

• **What is SECOR?** — Essentially nothing more than a satellite-borne transponder, SECOR (SEquential COllation of Range) comprises an electronic distance-measuring system.

By means of multiple-frequency

phase comparison techniques, range measurements are made in rapid sequence—independent readings can be made every 20 milliseconds—from three known ground stations and one or two unknown stations. These simultaneous range measurements then can be used to determine the geodetic coordinates of the unknown stations independent of the orbital parameters. This, according to engineer officers, is nothing more than a classical trilateration problem.

In the event one of the unknown stations is below the radio horizon of the SECOR satellite, the measurements of the known stations can be recorded, and measurements subsequently taken from the unknown stations. By applying the technique of a small segment of a short arc in the satellite orbit, the coordinates of the unknown station can be determined. Although there is some degradation in accuracy with this method, Army officials point out that the 30-meter accuracy over 1000 miles still far exceeds first-order survey requirements.

For optimum performance, the SECOR satellite should be placed in a minimum 600-n.-mi. circular orbit near the equator. However, Army officials say, if there is no choice of inclination, a polar orbit can be used. For triangulation across the Pacific, inclination of 50-60° is optimum and, since a rough rule of thumb is that the ground stations can be spread twice the orbital altitude, the higher the satellite, the better.

Under the Army's three-to-five-year geodetic program, there would be two SECOR launches a year, with the expectation that the satellites, designed for a lifetime of one year, would function for at least six months. Launch requirements could be varied as the program progressed. The main problem in the SECOR satellite is component reliability.

For example, the SECOR package on the *ANNA* satellite launched Oct. 31 failed approximately three weeks after launch due to a transistor failure. On this particular satellite, the failure was not as serious as it might have been: a back-up SECOR transponder was aboard. This second transponder will be turned on Dec. 19.

Currently, the engineers are redesigning the SECOR package so that transistor reliability will be less critical. Since the SECOR requires a transistor reliability of at least 2000 hours, this still is expected to be the determining factor in the number of satellites required for the geodetic program.

• **Ground equipment**—Expected to enter acceptance tests at the Cubic Corp.'s San Diego, Calif., plant soon, the ground equipment consists of three major units—an RF shelter, data shelter and storage shelter—plus various accessory units. The total station weight is about 28,000 lbs., and all units are designed to be air-transportable by both C-130 type aircraft and cargo helicopter. Six stations—four for operational use and two spares—are being procured by the Army; a second six are expected to be bought next year.

The RF shelter houses the SECOR transmitter and receiver and the antenna control console. The data shelter contains the frequency synthesizer, servos, data processors, tuning and sequencing control and recorder. Two 10-ft.-dia. parabolic antennas are used to transmit and receive signals from the satellite. In the storage shelter is housed the communications test equipment.

Two data processors—a Honeywell 300 and a Bendix G-150—are used to record the measurements from the satellite, with the latter checking the Honeywell for complete data reduction. Information and measurements are punched on paper tape in the field, but actual data reduction is to be done by the Army Map Service in Washington, D.C.

After initial data reduction, tapes will be stored. As further refinements of such error-introducing factors as ionospheric diffraction and orbital altitude variations are introduced, the tapes can be re-run and the order of geodetic accuracy increased.

Since a reading can be made in 20 milliseconds, the Army feels that the maximum time that will have to be spent in any one place will be about two weeks. In that time, approximately 8000 readings can be taken. Three frequencies are employed to gather data—421 mc as the transmitting frequency, 449 mc as the return and 224.5 mc as the ionospheric diffraction frequency.

Once the program gets under way next September, the Army expects to have a thoroughly tested system. Acceptance tests at the ground stations will have been completed and tests of the satellite/ground functioning will have been conducted as part of the *ANNA* feasibility program. ⁂

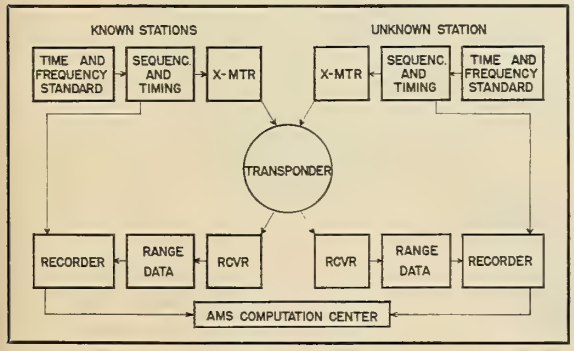
## Three-Stage Booster Favored for Voyager

*A SATURN C-1B CENTAUR* launch vehicle is expected to serve as the booster for NASA's advanced interplanetary spacecraft.

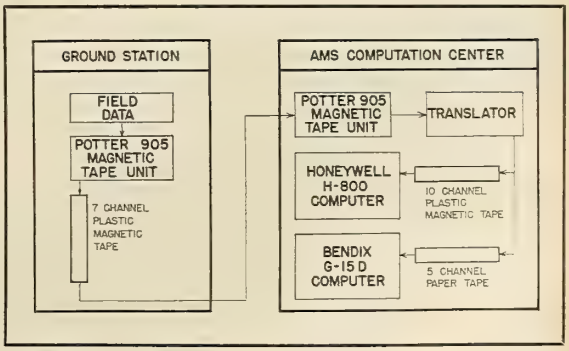
A top official of the agency's Office of Space Sciences disclosed that the three-stage vehicle is "strongly favored" as the booster for *Voyager* missions in 1966-67.

Continuing studies of the vehicle will be conducted, he said, and a recommendation for program approval is expected in the second half of 1963.

The booster would have an eight-H-1-engine first stage, a one-J-2-engine second stage, and the *Centaur* third stage composed of two RL-10 liquid hydrogen engines. Its payload capability for interplanetary missions would be 4000-5000 lbs. This is the minimum weight for *Voyager*, which is designed for advanced unmanned exploration of Mars and Venus. Other advanced projects are also likely to use the booster.




*INFORMATION flow shown on diagram of SECOR system.*




*PUNCHED tape data is fed to AMS for final reduction.*

# Decision-Making: Hostile or not Hostile?

*A few years ago this decision was relatively simple. The action that followed was relatively simple. Today the consequences of this type of decision-making can be enormous, affecting world-wide forces and events. The decision itself may trigger an incredibly complex series of interacting decisions and controls. In making these compressed-time decisions, commanders use man-machine systems which provide information processing assistance. The development of these large systems is the work of scientists, engineers and computer programmers at System Development Corporation. The system is their concern, not the actual design of hardware. Specifically, they contribute in these key areas: defining the requirements of the system, synthesizing the system, instructing the computers within the system, training the system, evaluating the system. Throughout they seek to optimize man-computer relationships and to develop a system which grows and changes with the needs of the decision-makers who use it. Human factors scientists, operations research scientists, systems-oriented engineers and computer programmers interested in joining a close interdisciplinary effort are invited to write concerning new positions in this expanding field. Address Dr. H. C. Best, SDC, 2433 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C., Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."*

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11-237

# Technical Countdown

## ELECTRONICS

### Laser Range Finder Highly Accurate

Raytheon reports development of a highly accurate range finder that employs a laser as the principal measurement mechanism. The 30-lb. twin-barreled device "fires" a 20-ft. length of light at a target from one tube and picks up the reflection with a photomultiplier tube in the other. A tiny computer measures the time difference and computes distance. Tests so far have shown an accuracy capability within 5 ft. The chopper used to control beam length reacts in 20 billionths of a second, say Raytheon developers.

### From Advent to Syncom to Satcom

The first satellite communications support vessel, the USNS Kingsport, officially was accepted by the U.S. Fleet Dec. 8. The ship, outfitted by Bendix Systems Division first for *Advent* and then for *SynCom*—the NASA synchronous orbit communications satellite—ultimately will assist in development of the newly organized high and low orbit military communications satellite programs. The mobile station will assist in checking the surface-coverage limits of these several future communications satellites.

### Kingsport Has Atlas 3-Axis Tracker

Among the many new systems installed aboard the new communications terminal USNS Kingsport (see above) is the TRIAX antenna developed by General Electric. Capable of operating in three axes, the 30-ft. dia. tracking dish weighs 58,000 lbs. It is reportedly capable of an accuracy of ±0.5 milliradian up to a ship's roll of ±15°, a pitch of ±5°, and vertical heave of up to 0.15 g. The antenna will employ the same gearless drive developed by G.E. for the *Atlas* ICBM guidance ground control system.

### MM to Use Functional Circuits

The advanced guidance system for the Air Force's *Improved Minuteman* (WS-133B) will make extensive use of microminiaturized integrated electronic circuits. Award of a "substantial" contract to Westinghouse to supply such circuitry was announced last week by North American Aviation. Autonetics Division of NAA, MM guidance associate prime, will receive a first delivery late this month for test evaluation. The functionally complex molecular electronic components are expected to contribute considerably to reducing guidance system size and cost and further improve system reliability, the company claims.

### More Microcircuit Advances Predicted

Two Sperry-Rand scientists at the recent Fall Joint Computer Conference in Philadelphia predicted early improvements for thin-film interconnection techniques which will make practical submicrosecond, million-bit memories. Advance work, they report, should yield high packing densities of 5000-10,000 bits/sq. in. and low drive currents of 50 ma. Improved material properties should make coincident current selection with coherent rotational switching possible. With better techniques, high-density integrated memory stacks with access lines made on the same substrate with the film seems likely, they asserted.

### Crystal Filter Developer for SS-FM

Qualification tests of a new crystal filter developed by Collins Radio Co. as a potential replacement for mechanical subcarrier separation comb filters are scheduled for completion this month. The new units, developed for *Saturn's* single sideband-FM telemetry system, reportedly cost 80% less, give equal performance, are less sensitive to vibration and circuit loading, and are reported to be more stable under temperature changes than a new ceramic unit also developed for this application. Present mechanical filters are small and efficient but expensive, fragile, and difficult to produce. The crystal filters will replace the mechanical units, with no redesign of already-qualified circuits and mounting hardware.

## PROPULSION

### Missile Models Travel at Mach 16

Fragile missile models are being shot down a 1000-ft. hyperballistics range at 18,000 fps without damage. Equivalent to Mach 16, this speed is said to be the highest known velocity achieved by scaled models of aerodynamics configurations without destroying them. Propelled by a two-stage launcher installed at the U.S. Naval Ordnance Laboratory, White Oak, Md., the models are photographed during their split-second flight at a series of special recording stations. Analysis of the processed negatives yield required aerodynamic data.

## ADVANCED MATERIALS

### Higher Hi-Temp Standard Available

A new pyrometric lamp, developed by Mole-Richardson, permits accurate calibration of pyrometers at 3803°K. The instrument is also expected to find use as a standard radiation source for spectro-radiometery. Operation involves controlled generation of an arc between two high-purity graphite electrodes. The heated graphite reaches sublimation temperature, providing a reproducible radiation source with a brightness-temperature variation of ±20°. (The highest calibration source commercially available previously was a tungsten-strip lamp capable of about 2573°K.)

### Temperature Effects on Materials Viewed

The grain structure of a material as it changes under the stress of temperature variations will soon be seen by Rocketdyne scientists. They soon will have operational a unique vacuum furnace that will provide microscopic observation of thermal transition phenomena in metals and their alloys at temperatures up to 3270°F.

### Ames to Get Two New Shock Tunnels

Under a $1.5-million Ames Research Center contract, announced by NASA last week, Thiokol Chemical Corp. will build two hypervelocity test units for re-entry studies. The units will combine light-gas-gun and shock-tube techniques to attain velocities to 50,000 fps. Shock tubes will be fabricated from surplus 8-in. and 16-in. naval guns. A major design problem includes development of quick-opening valves that must close within 100 msec. after actuation and must operate under 30,000 psi pressure.

# 'Footprints' May Guide X-20 Vehicle

## *Equations of motion continuously plotted, displayed*

by William Beller

X-20 PILOTS may be guided to a landing site by displays that continuously and accurately show the changing "footprint" of the ground area within the *Dyna-Soar* vehicle's range.

For early flights, the displays may be incorporated in a ground-based back-up system; later flights may see the system airborne, as its estimated weight is only 40 lbs.

The concept of the display is a general one that is also proposed as a way to ease the guidance and control problem for spacecraft missions such as satellite intercept and lunar landing.

• **Controlling hypersonic craft** — Most major missile/space manufacturers are at work on some form of energy-management system for monitoring the trajectory patterns of lifting spacecraft. The problem is to make the predictions fast enough and accurate enough for the pilot or astronaut to be able to act on them.

An Air Force engineer has suggested the use of rapidly generated, accurate performance footprints for spacecraft; he has also proposed that the concept be given a practical test as a back-up guidance system for the *X-20*.

Capt. Frank R. Anderton, Jr., USAF—attached to the manned spacecraft engineering office, Air Force Flight Test Center, Edwards AFB—said at a recent AF briefing that if the onboard guidance of the *X-20* failed, the proposed ground-based backup would be able to give a pilot the information needed to navigate to destination or an emergency site.

Capt. Anderton told MISSILES AND ROCKETS that unlike the onboard *X-20* system, the backup is based on a continuous evaluation of the vehicle's equations of motion; it does not rely on a set of pre-computed trajectories. For this reason, the backup system would have relatively better accuracy and also could be used as a standard for the flight system.

• **New use of old technique**—Predictive control is not new; it is almost as old as the modern analog computer. It was used during World War II in radar tracking devices and for anti-aircraft fire control; the guns were aimed not at the aircraft but where computations predicted the aircraft would be when the shells arrived.

The technique was to run the computer ahead of real time.

For the *X-20*, the concept is simply to speed up the time scale so the computer solves the vehicle's equations of motion—or simplified equations of motion—in less than one-tenth of a second, thus predicting the end conditions which would be displayed.

The idea of using the technique for a display for energy management of a vehicle is fairly new and has not been sufficiently exploited, according to A. E. Rogers, of the Research and Computation Div. of Electronic Associates Inc., Princeton, N.J. One of the leading companies in the analog computing field, Electronic Associates is helping the Air Force work up the computational aspects of the problem.

• **Getting the footprint**—For the booster burnout conditions shown in Fig. 1, the glider has a total range variation capability of about 20,000 n. mi.: by flying the angle-of-attack for maximum lift-drag, the vehicle can reach more than 25,000 n. mi.; by flying for minimum lift/drag, the range is reduced to below 5000 n. mi.

Immediately after booster burnout, the vehicle's range capability is reduced by more than 100 n. mi. per second, chiefly a result of aerodynamic drag decreasing the vehicle's total energy. This rapid change shows the need for the pilot to have fast and accurate flight information.

As the vehicle continues through its trajectory, the range capability continues to get smaller and smaller until it degenerates into a point.

The total glider-maneuvering capability is shown by an outline called the footprint. It shows on-course as well as off-course maneuvering capability.

Footprint size and shape, according to Anderton, depend on the instantaneous values of vehicle velocity, heading, altitude, flight-path angle, and position over the Earth, as well as vehicle lift/drag. Whenever aerodynamic forces are acting on the vehicle, the footprint size and shape are changing. There is, therefore, a unique footprint for each set of flight conditions.

A completed footprint as it would be displayed to the pilot or to the energy-management monitor is shown in Fig. 2. Anderton includes several reference lines, indicating downrange and cross-range capability at intermediate angles of attack in addition to the basic outline.

By using the reference lines, the pilot or ground monitor can determine the combination of angle of attack and angle of bank required to arrive at the destination. To reach the landing site shown, for instance, the pilot can see that he should fly an angle of attack of 25° and angle of bank of 30°. ⌗

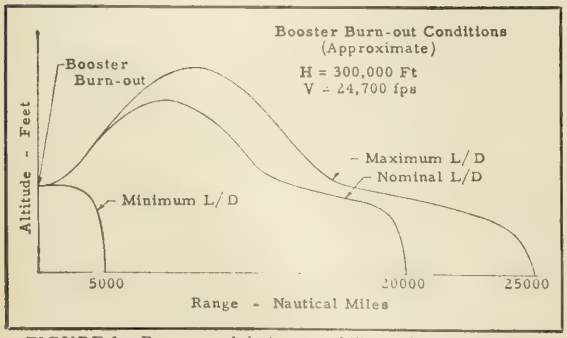
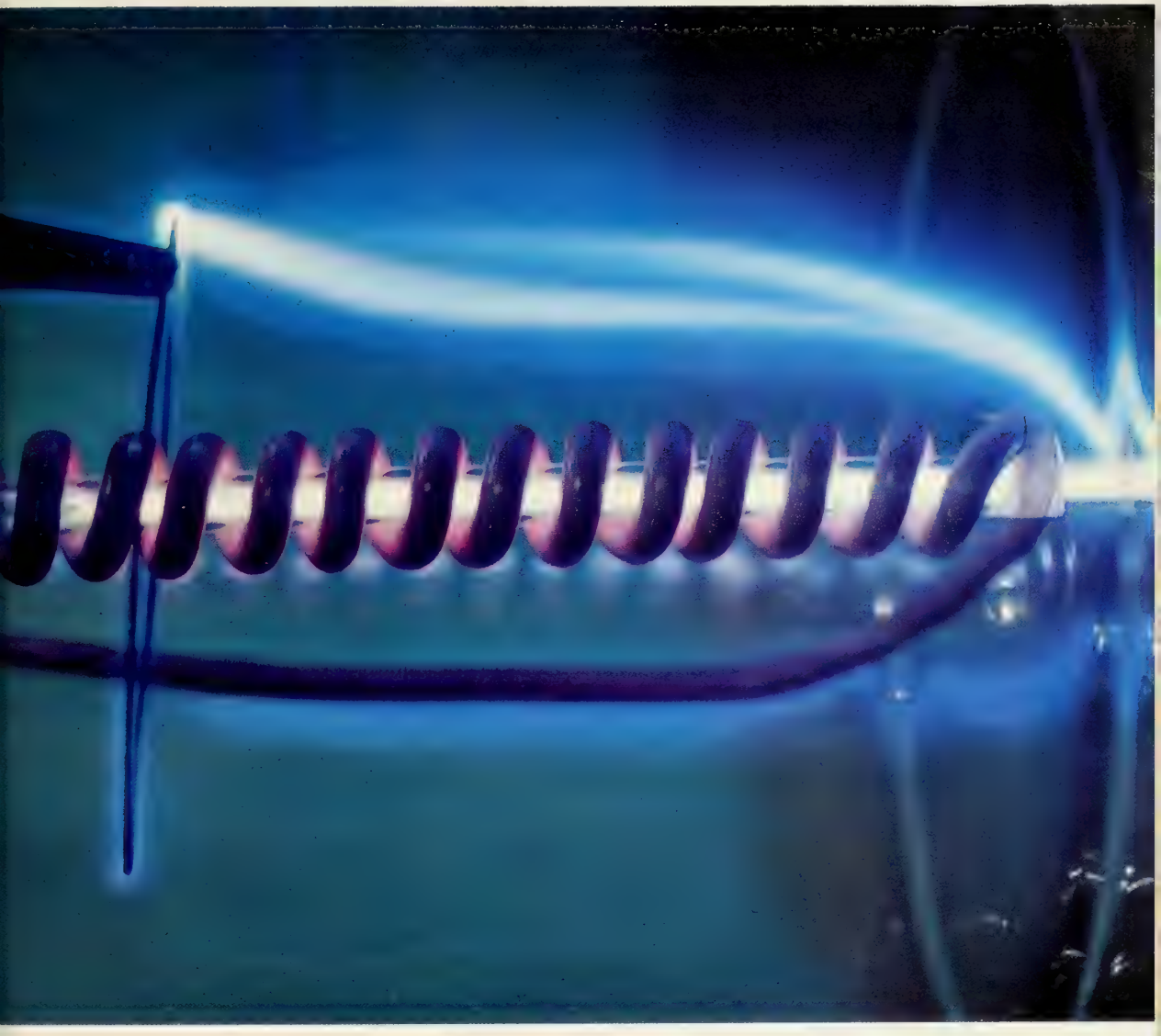



*FIGURE 1—Range modulation capability at booster burnout.*




*FIGURE 2—Complete footprint.*



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GAIN
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DC LINEARITY
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**Model 1137**
**DC Excitation and Calibration Unit**



CURRENT OUTPUT
0 to 100 ma

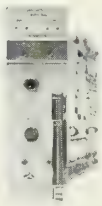
VOLTAGE LEVEL TO TRANSDUCER
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NOISE (Including Ripple)
±0.005% rms of full scale

VOLTAGE STABILITY (24 Hours)
±0.01% of full scale

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(Amplitude)
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FREQUENCY RESPONSE
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INPUT IMPEDANCE (3 kc)
0.1 megohm minimum

OUTPUT IMPEDANCE
Less than 1 ohm

**Model 1133**
**AF Frequency to DC Converter**



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11



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# Additional Bikini Funding Is Imminent

***Republic photo-recon vehicle for Army, Marine Corps said to cost less than comparable devices now in use***

**by Michael Getler**

MINEOLA, L.I., N.Y.—Additional funding is expected soon for the *Bikini* photo-reconnaissance drone—a system Republic Aviation Corp. claims would cost far less than any comparable device now in service.

Republic's Missile System Div. says recent *Bikini* flight tests met with "reasonable success," but also emphasized the need for more development effort to improve reliability.

*Bikini* drones were damaged in three of nine flights last September at the Twenty-Nine Palms, Calif., Marine Corps base. The tests, however, demonstrated feasibility, according to Republic.

• **Developmental history**—Development of the drone, a low-budget experiment aimed at putting a lightweight and easy-to-operate photo-recon system in the hands of a battlefield commander, has been supported in its early phase under an Office of Naval Research contract.

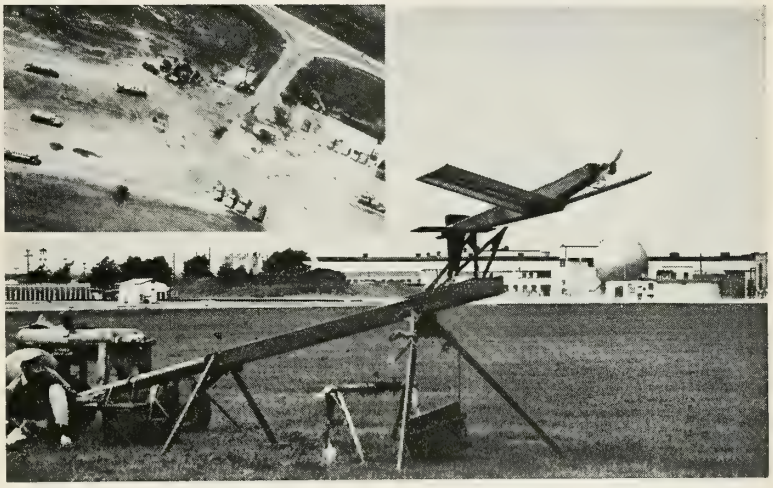
A proposal to continue development was submitted by Republic in April after a joint Army-Marine Corps flight demonstration at Quantico, Va. during which the firm reports: "excellent flights and excellent photos" were achieved.

*Bikini*, even in its current experimental configuration, is an extremely simple and lightweight device. Weighing in at 35 lbs., including camera payload, the drone reportedly has an in-flight endurance of 30-40 min., operates at altitudes to roughly 5000 ft. above sea level, and would provide recon capability within a 5-10 mi. radius.

The drone, according to Republic, has a limited all-weather capability, depending mostly upon the camera payload. A modified version could also fulfill a night photo-reconnaissance role.

Cruising speed of *Bikini*—named for its simplicity, economy, and reported ability to cover strategic areas—is normally below 115 mph.

• **System Design**—The airframe is of reinforced plastic, cutting down on weight and radar reflectivity: The system, in addition to using an assortment of off-the-shelf model airplane parts, is powered at under 5 hp. by an unusual 2-cycle, 2-cylinder engine.



*FIELD SETUP shows test version of Bikini photo-recon drone on rail launcher. Inset is representative aerial photo taken by drone, which has ceiling of about 5000 ft.*

Radio-command guidance is used, and is similar to the system proposed by Republic for the Army's *USD-3* drone, with five channels currently employed by the ground controller for aileron and rudder commands, throttle setting, camera activation, and deployment of the 12-16 ft. recovery parachute packaged within the fuselage.

Engineers see no problem in meeting command-system security requirements for drones with these limited ranges. Control beyond visual range has been achieved in flight tests to date, Republic reports, through use of a tracking piot at the control site.

An unusual airframe design extends the vertical stabilizer considerably beneath the fuselage, where, Republic claims, it can best increase maneuverability under certain flight conditions, and also reduce the chance of snagging the parachute during recovery.

For Marine or possibly Army use, a helicopter-transportable mechanized package would probably be developed compatible with the vertical assault concept. According to Republic, a single mechanized "mule" type vehicle—mounting three drones, spare parts, the pneumatic launching system, and control equipment—would weigh less than 500 lbs.

The system, designed to complement the Army's far more sophisticated *USD-2* drone, could be operated throughout an entire mission plan by two men, the firm claims.

Engineers here have also re-designed the rail-launcher system, shortening it some from the prototype version and substituting a rubberized pneumatic accumulator for the metal one used to date.

Engineers point to these *Bikini* assets: small size, making visual detection difficult; ability to operate beyond small arms fire range, relatively quiet operation at altitude, small radar cross-section, and poor Doppler signal because of low speed. ⌘

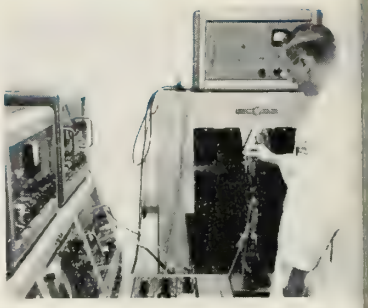
*Thiokol Research with High-Energy Oxidizers opens new*

# PROPULSION PATHS

## WHERE SIZE COUNTS...

Thiokol's pioneering broke the size barrier on solids. Continuing R&D at Thiokol has been responsible for scores of technical breakthroughs leading to production of the most reliable propulsion systems in rocketry's current catalog.

At present, Thiokol scientists are engaged in development of new super oxidizers for solids application. A greatly enlarged microphotograph of one of these crystalline, high performance ingredients is shown in insert illustration below. Promising vastly improved performance–greater lift, range, and payload delivery–in motors now flying, new Thiokol-developed oxidizers will also increase adaptability of solid systems for upper stages of space vehicles, enhance punch and reliability of big boosters.



*NUCLEAR MAGNETIC RESONANCE SPECTROMETER. Advanced scientific apparatus used to determine molecular structure of exotic fuel components for purposes of predicting their behavior.*

*Micro photo of high energy oxidizer.*

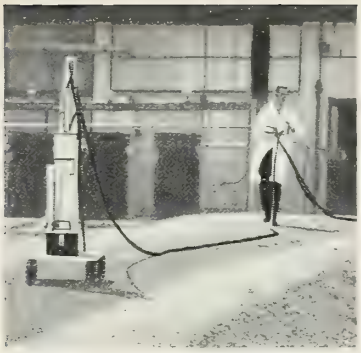


# TO SPACE

## WHERE PERFORMANCE COUNTS...

Thiokol is taming many exotic liquid fuels for space flight. Research has already achieved several new propellant combinations capable of providing missions of longer duration with greater payload capacity than other space storables and advanced cryogenics.

In actual firings of oxygen difluoride/diborane on the thrust stand, for example, Thiokol is establishing injector performance, developing ablative and other chamber cooling techniques and defining propulsion system performance.



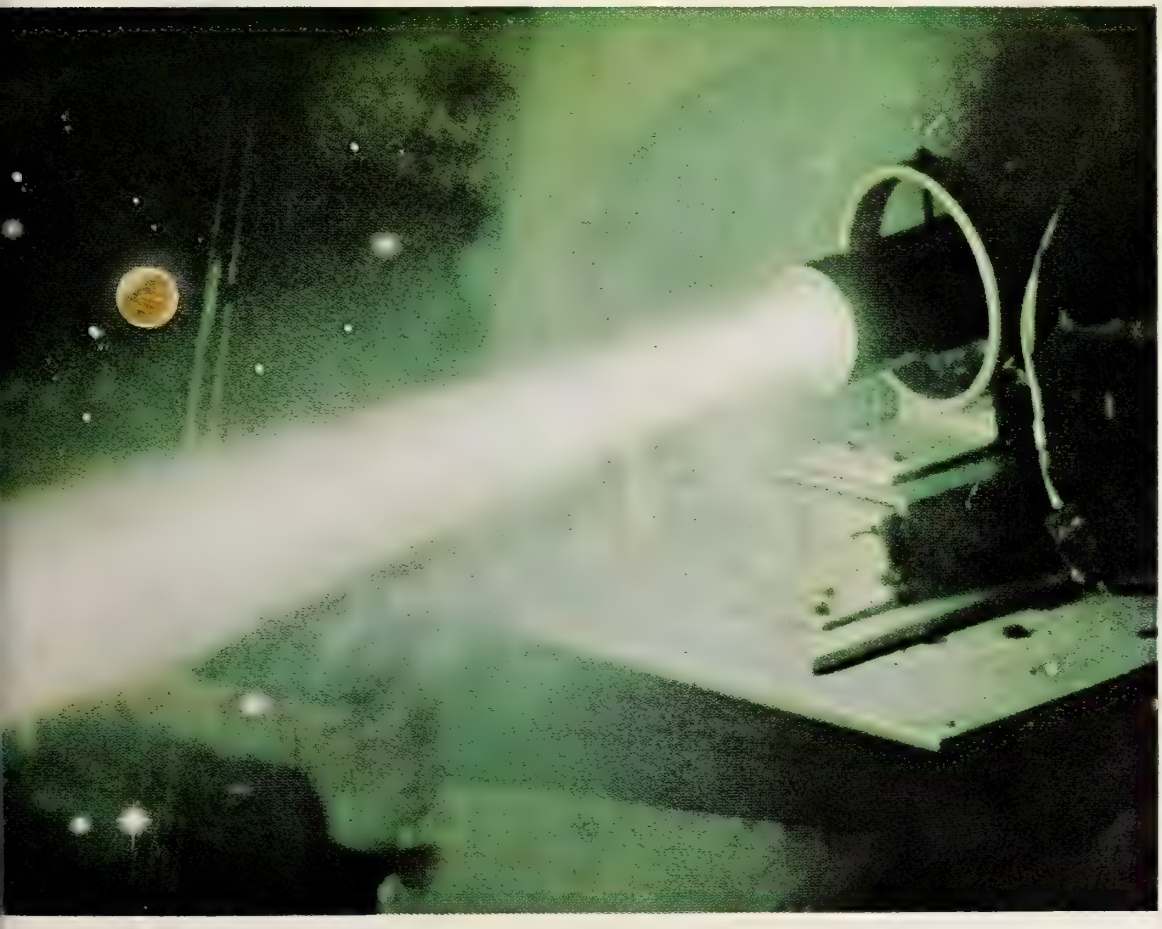
*ROCKET ROBOT. Remotely controlled device carries experimental motors and "hot" propellant compounds from lab to test area. Speeds developmental work.*

Thiokol CHEMICAL CORPORATION
BRISTOL, PENNA.

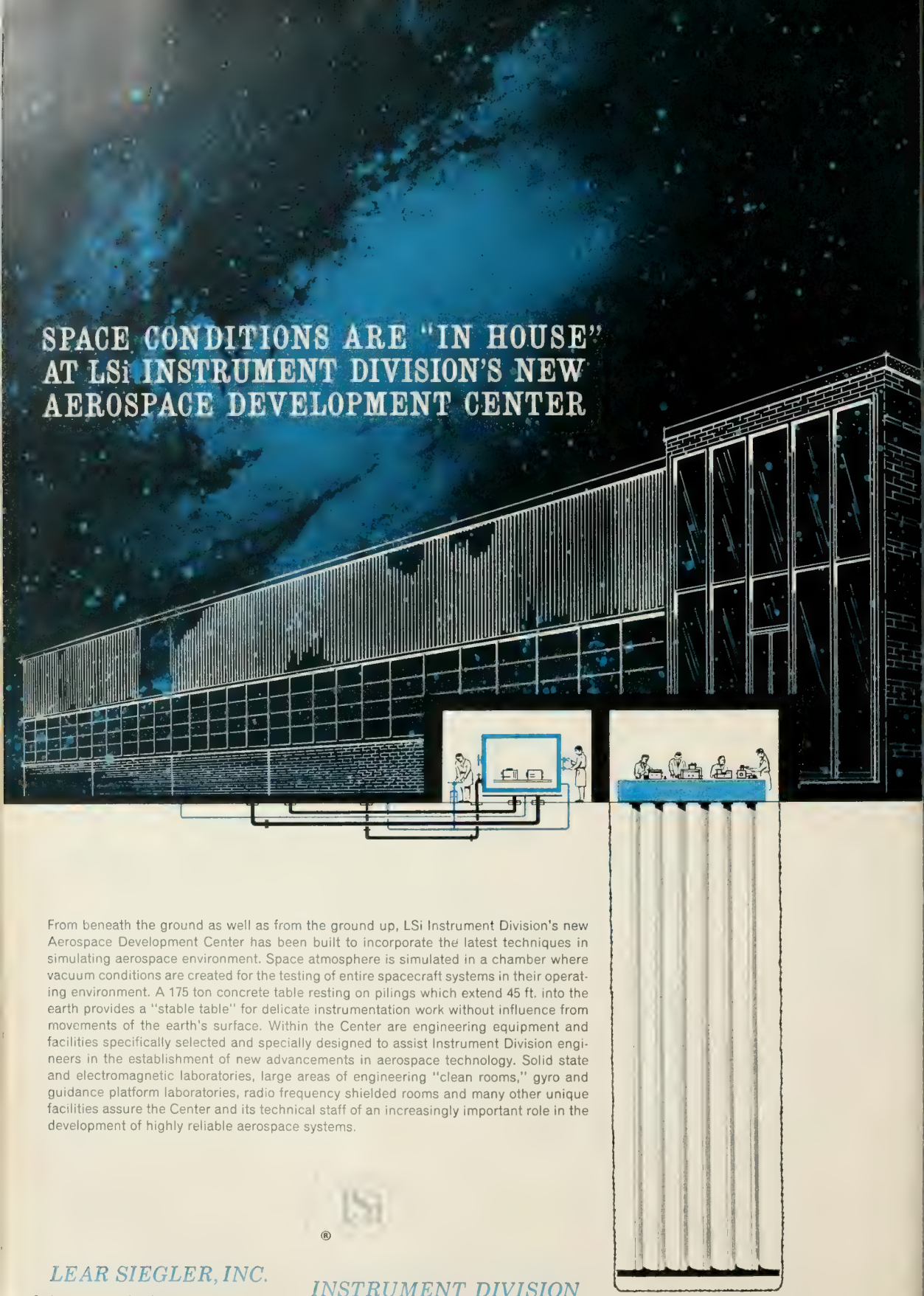
Rocket Operations Center: Ogden, Utah

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# Nuclear Safety Funds May Double

## *AEC spending could hit $17 million in Fiscal 1964*

by Frank G. McGuire

AEC's BUDGET for safety in nuclear space programs is expected to double in the next year. Current funding, including flight-test costs, stands at about $6 million. Fiscal Year 1964 may see as much as $17 million spent on safety.

The commission is planning to buy five to seven *Scout* launch vehicles for its flight-test program, and launch operations will be handled by NASA from Wallops Island. Along with the flight-test program, AEC will conduct a series of SNAPtran (SNAP transient) tests at its Idaho Falls, Idaho, facility, running the reactors to destruction for data-gathering purposes.

Three major contractors are involved in the immediate program, in addition to AEC and supporting government agencies. The contractors—Atomics International for the nuclear packages, Sandia Corp. for flight tests, and Phillips Petroleum for ground tests—are responsible for the program. AEC oversees the work.

The commission's assistant director for nuclear safety, Dr. Joseph A. Lieberman, whose office was established a year ago, says his safety program's activities are funded independently of individual SNAP programs. The budget covers operating expenses, not administrative costs such as salaries. Administrative costs are borne separately by AEC.

The first non-nuclear reactor flight demonstration (RFD-1) is scheduled to take place from Wallops Island in the spring of next year, using a simulated SNAP-10A reactor. Ballistic re-entry will be at about five or six degrees, with total heat input to the package about equal to that of a re-entering satellite. Data from the test will be obtained through facilities on Bermuda.

• **Program's aims**—In the continuing program, Dr. Lieberman says, every flight test will have a complete backup vehicle and payload in case the initial test does not return adequate results. The tests are to determine how reactors behave under all conditions that could conceivably spread radioactive contamination, such as launch pad impact, sea impact, fire, unscheduled re-entry, and similar hazardous circumstances.

"There are unquestionable international implications here," he points out, "and we're our own toughest customer on safety considerations."



*AIR FORCE technicians at Holloman AFB prepare SNAP-10A unit for impact tests.*

Howard G. Hembree, head of the Engineering Test Branch in Dr. Lieberman's office, says his organization runs engineering analyses of systems, but the ultimate responsibility for safety of nuclear systems rests with the contractor. AEC has no actual project responsibility; it can only suggest system modifications.

Sandia, doing considerable R&D work on re-entry burnup characteristics, will also furnish assistance in the orbital SNAPshot reactor test program, but will not fabricate payloads.

SNAPshot, mounted in an *Agena-B* vehicle, will use a SNAP-10A reactor to power its own sensors and instrumentation during a planned orbit of tens to hundreds of years. No attempt will be made to re-enter the payload intentionally after startup, and AEC hopes to get long-life operating data.

Safety calculations on the payload are being made in ground tests simulating more stringent conditions than are expected in orbit. First launch in SNAPshot is slated for next year, using an *Atlas-Agena,* from Vandenberg AFB, Calif.

In the *Scout* ballistic tests from Wallops Island, the Air Force Special Weapons Center will supply downrange aircraft and instrumentation similar to that used in the ballistic pod re-entry tests conducted with *Atlas* vehicles from Cape Canaveral (M/R, Nov. 5, p. 38). The *Atlas* pods were for isotopic SNAP units only.

• **Ideas welcome** — Dr. Lieberman says his office is receptive to any qualified contractor ideas for successfully insuring the safety of nuclear space hardware, but there is no active program underway to seek such suggestions. This is because of the highly specialized nature of the work and the fact that a flow of information has already been established among nuclear contractors.

Subcontracting on the program is handled through the principal industrial companies, not directly with AEC—much as in the Air Force system of funneling all system work through one central contractor. Virtually all the aerospace nuclear safety funding has been spent with industry, Dr. Lieberman says, adding that industry contributions will be mainly in the subcontracting field.

• **Major safety areas** — The aerospace nuclear safety program is divided into four areas: research and development, ground environment, flight test, and reactor kinetics. The research and development phase is concerned with physics of the upper atmosphere, thermodynamic heating rates, ablation mechanisms, diffusion, dispersion and resident times of ablated system particulates.

The ground-environment phase encompasses experiments to simulate aborts on the pad, or during ascent, injection or re-entry portions of a mission. The flight tests are flight demonstrations of models or prototypes. This phase contains the proof of safety for systems. ❖

# High-gain Antennas Urged for ComSats

***STL's Mueller tells how concept could be used for TV broadcasts to Africa, or secure military communications***

NARROW-BEAM antennas can be used on satellites to provide blanket coverage of newly emerging nations by television relay or to establish highly secure radio tactical command and control communications.

Antennas of up to 40 ft. in diameter aboard presently conceived communications satellites would significantly extend the ComSats' existing capabilities without imposing a heavy weight or redesign penalty.

Details of such a system were presented by Dr. George E. Mueller, vice president of Space Technology Laboratories, Inc., at a local section meeting of the American Rocket Society in Washington, D.C.

Utilization of high-gain antennas would be an improvement of existing synchronous, stabilized communication satellites, rather than a second-generation approach, Mueller declared.

He also emphasized that, while power requirements would be kept low, more power could be directed to ground receivers. And he said this could be achieved without the degradation of reliability corollary to high satellite-transmitter powers.

• **Antenna needs**—Two design considerations will limit practical spaceborne antenna size, Mueller pointed out. Of greater importance is the fact that for a given frequency beamwidth decreases as antenna diameter increases, thus requiring higher and higher spacecraft attitude control accuracies.

For reliable area communications, Mueller said, pointing accuracy requirements could be roughly 10 times those demanded by any of the currently proposed communication satellites. He emphasized, however, that this is still only one-tenth the stabilization accuracy to be employed in NASA's *Orbiting Astronomical Observatory*.

The second consideration, Mueller pointed out, involves antenna size and torque, particularly in diameters of 50-100 ft. Significant torques are likely to be developed as a result of solar radiation pressure, he asserted. Thus, there will be a need for an attitude control system capable of providing continuous corrective torques. And he emphasized that the movements of such a structure will require significant increases in the size of control system inertial elements.

Spaceborne antennas, such as the Sunflower collectors, have been designed and fabricated measuring 15 and 32 feet in diameter and weighing 84 lbs. and 143 lbs., respectively. Other paraboloids that can readily be built up to 50 ft. in dia., he said, could be folded umbrella-like for launch.

• **VOA-type broadcasts** — Employing antennas of 20-ft. diameter (100 lbs.) or 40-ft. diameter (170 lbs.), including all support and deployment equipment, would not add excessively to satellite weight, Mueller claimed. Resulting satellite design perturbations would be small, added thermal control could be handled passively, and larger disturbing torques would require less than 1 lb. of extra weight for reaction wheels.

Such a narrow-beam satellite would be ideal, he suggested, for Voice of America broadcasts to new nations such as those emerging in Africa. Placed in synchronous orbit above the equator at 15°W, one satellite would provide complete coverage of Africa. At that longitude, the space station would have an elevation angle of 6.4° above the horizon from New York City and have a slant range of 22,000 n. mi. (See Table 1 for the geometric parameters of three widely separated typical receiving sites.)

• **TV practical** — For relayed television broadcasts to this region from New York, Mueller said, the satellite would require a separate, small antenna to receive a signal at SHF, or it could

TABLE 1. GEOMETRICAL PARAMETERS FOR THREE RECEIVING SITES, WITH 24-HOUR EQUATORIAL SATELLITE AT 15°W

| | Timbuktu, French West Africa (2°W, 15°N) | Windhoek, Southwest Africa (15°E, 22°S) | Mogadiscio, Somalia (45°E, 0°) |
|---|---|---|---|
| Great Circle from Subsatellite Point | 19.8° | 36.6° | 60° |
| | 1,185 N. Mi. | 2,195 N. Mi. | 3,600 N. Mi. |
| Elevation Angle | [illegible] | 46.9° | 21.9° |
| Range from Satellite | 19,564 N. Mi. | 20,130 N. Mi. | 21,251 N. Mi. |
| Free Space Losses (at 800 mc) | 181.6 DB | 181.8 DB | 182.5 DB |
| Angle from Vertical at Satellite | 3.4° | 5.9° | 8.0° |

TABLE 2. COMMUNICATION CHARACTERISTICS OF A SYNCHRONOUS SATELLITE WITH 40-FOOT ANTENNA, 800 MC

| | |
|---|---|
| Satellite Radiated Power (10 Watts) | 40 DBM |
| Satellite Antenna Gain | 38 DB |
| Antenna Beamwidth | 4° |
| Ground Antenna Gain | 12 DB |
| Space Loss | —182 DB |
| System Losses | — 3 DB |
| Receiver Signal Power | — 95 DBM |
| Receiver Noise Density (200°K Receiver) | —116 DBM/MC |
| Receiver Noise Bandwidth | 3 MC |
| Receiver Noise Power | —111 DBM |
| Input S/N | 16 DB |

TABLE 3. CHARACTERISTICS OF A SYNCHRONOUS COMSAT FOR COMMAND AND CONTROL

| | 800 MC 40-ft. dia. Satellite Antenna | | 4000 MC 20-ft. dia Satellite Antenna | | | |
|---|---|---|---|---|---|---|
| | | | Wideband | | Narrowband (Four 30-kc Channels) | |
| | Up | Down | Up | Down | Up | Down |
| Transmitted Power (DBM) | 50 | 40 | 50 | 36 | 50 | 30* |
| Transmitter Antenna Gain (DB) | 26 | 38 | 29 | 46 | 29 | 46 |
| Antenna Beamwidth | | 2° | | 0.75° | | 0.75° |
| Space Loss (DB) | —192 | —182 | —198 | 198 | —198 | —198 |
| System Losses (DB) | 3 | — 3 | — 3 | — 3 | — 3 | — 3 |
| Receiver Antenna Gain (DB) | 35 | 2 | 46 | 29 | 46 | 29 |
| Receiver Signal Power (DBM) | — 74 | — 95 | — 76 | — 90 | — 76 | — 96 |
| Receiver Noise Density (DBM/MC) | — 0 | —116 | 110 | — 15 | 10 | —115 |
| Receiver Noise Bandwidth (MC) | 0.1 | 0.1 | 3 | 3 | 0.03(X4) | 0.03 |
| Receiver Noise Power (DBM) | —120 | —126 | —105 | —110 | —119* | —125 |
| Input S/N (DB) | 46 | 31 | 29 | 20 | 43* | 29 |

* DBM or DB per Channel, as Noted.

TABLE 4. CHARACTERISTICS OF A SYNCHRONOUS COMSAT FOR MOBILE-TO-MOBILE UNITS, 8000MC, 40-FT. DIA. SATELLITE ANTENNA

| | 2-ft.-Dia. Ground Antenna | | Dipole Ground Antenna | |
|---|---|---|---|---|
| | Up | Down | Up | Down |
| Transmitted Power (DBM) | 50 | 36 | 40 | 34 |
| Trans. Antenna Gain (DB) | 32 | 58 | 3 | 59 |
| Antenna Beamwidth | 4° | 0.2° | 180° | 0.2° |
| Space Loss (DB) | —204 | —204 | —204 | —204 |
| System Losses (DB) | — 3 | — 3 | — 3 | — 3 |
| Receiver Antenna Gain (DB) | 58 | 32 | 58 | 3 |
| Receiver Signal Power (DBM) | — 67 | — 81 | —106 | 1 0 |
| Receiver Noise Density (DBM/MC) | —110 | —115 | 0 | —115 |
| Receiver Noise Band (MC) | 0.03 | 0.03 | 0.003 | 0.003 |
| Receiver Noise Power (DBM) | —125 | —130 | —135 | —140 |
| Input S/N (DB) | 58 | 49 | 29 | 30 |

employ an offset feed on the receiving antenna, accepting the loss in gain that results. Relay to African homes would then use the large antenna to transmit in the 800-mc broadcast band.

One possible configuration places the antenna at the extreme end from a solar-cell array to minimize interference by the large antenna. Since the satellite rotation will interpose the antenna between the satellite and the Sun periodically, storage batteries capable of 12-hour operation without charging would be required. Otherwise, an open-mesh antenna reflector might be used so that the solar cells would generally be in view of the Sun.

Mueller said the large antenna, canted about 5° to the local vertical, would aim at a point on Earth to keep to a minimum the angular excursion required at the satellite to direct its beam toward the selected receiving areas. The geometry of the situation would place this point in the French Congo, about 2°N, 15°E.

Mueller suggested use of a multiple antenna feed to direct antenna-radiated energy in the several required directions simultaneously. Employing a 40-ft. antenna and assuming a 10° total angle to cover Africa, would call for a number of feeds for complete coverage, he asserted. Since the number of repeaters available in the satellite is limited, either a mechanical movement of the feed for each repeater or a nest of feeds with ferrite switches for feed selection could be employed. Reduction in antenna gain at the extreme excursions would be less than 1 db, Mueller calculated.

Using a 40-ft. antenna and assuming a transmitted frequency of 800 mc, satellite antenna gain would be 38 db, he observed. If 6-element arrays (with 12-db gain) were provided on the African homes, with very high-quality receivers (about 200°K noise temperature), a 3-mc television signal could be relayed satisfactorily by transmitting 10 watts from the satellite (see Table 2). However, he estimated, a 20-ft. antenna, providing 31-db gain, would require 40 watts for equivalent ground reception.

Almost complete coverage of Africa (e.g., the relayed signal could on command be aimed at almost any home in Africa), could be provided from the same satellite by using a multiple feed system centered at about 10°E on the equator. The antenna feeds would need to be offset from center about 4° maximum.

• **Military applications** — A communications satellite with a high-gain antenna would be useful in military applications for directing narrowband messages to field forces or reasonably wideband one-way transmissions from Headquarters to Area Command Centers, Mueller pointed out.

One of the principal advantages of narrow-beam antennas is their inherent resistence to jamming resulting from the limited geographical coverage.

By trading off the 3-mc bandwidth for four or five single or grouped voice channels (see Table 3) the same satellite could provide coded transmissions to aircraft or to ground receivers.

The optimum frequency for this application, said Mueller, is higher than 800 mc, possibly 4000 mc, as a reasonable compromise. (A 600-mc wide band is already allocated to military communications in that frequency region.)

Even more directly applicable to military needs, the scientist asserted, might be the use of this type of satellite for two-way communications between mobile units, such as between company and battalion, or between company and tactical aircraft support under actual field conditions (see Table 4).

In this application, Mueller said, it probably would be desirable to use a reasonable amount of directivity in the ground antenna. Further, since more frequencies are available at higher frequencies, it may be desirable to consider operating at 8000 mc, also already assigned to the armed services.

For such a military application, Mueller claimed, presently designed communications satellites offer significant limitations. Since only about four two-way channels can be built into a satellite capable of being launched by today's boosters, the scientist suggested use of some method of time and "beam" sharing to permit an appreciable number of operating units to use the communications service.

Because very narrow beamwidths are desirable, an automatic scan and lock mode of searching through the multiple antenna feeds could be used along with some form of emergency channel override. This, he said, would allow allocation of communications on a priority basis. ⌗

# Probes' Data-System Design Questioned

## *No-high-speed requirement could add reliability, flexibility*

PHILADELPHIA—A proposal for a one-way, unmanned voyage to Mars, set forth at the Fall Joint Computer Conference here, was coupled with a strong plea for greater emphasis on design of the information-processing subsystem as the key to profitable interplanetary exploration.

Commenting on development of planetary probes, T. B. Steel, Jr., of Systems Development Corp., Santa Monica, Calif., said "although many of the basic problems (propulsion, guidance, etc.) are well in hand, the vital question of providing real-time direction to the resulting complex of equipment, surprisingly, has been almost totally ignored."

In a paper presented to the recent conference, Steel set out "to explore this gap in the science of astronautics."

He began by strongly stressing the need for complete systems analysis of the entire probe and its mission prior to design and programing of the vehicle computer.

As envisioned by Steel, a one-way soft-landing probe to Mars could be launched in December, 1966, aboard a three-stage *Saturn* vehicle. Current estimates, he says, suggest that a 2500-kilogram payload can be placed in circum-Martian orbit at about that time. After being in a transfer ellipse for about 252 days, the probe would enter a terminal maneuver early in September, 1967, landing in the southern hemisphere at the beginning of the Martian spring—a relatively good time for data gathering.

However, probably no more than 90 days would be available for acceptable data transmission from Mars, because of movement of Earth to within 30 degrees of the Sun as viewed from Mars. Steel notes that although the Martian surface environment—temperature and atmosphere—is clearly submarginal for men, it is "relatively benign" to machinery. "This happy situation," he says, "is far from general in the solar system."

With the main instrument package immobile, but with some smaller devices and communications equipment slightly extending the horizon and exploratory range of the probe, Steel expects the exploration capability of the probe to be limited to roughly 50 sq. km. Instrumentation will include thermocouples, IR, UV, and visual-light-sensitive photometers, seismographs, particle radiation detectors, and other passive recording devices. Also, biological and mineralogical specimen collectors and analyzers.

To the information-processing subsystem, Steel points out, these devices will all be digital signal generators with variable data rates and parameters subject to alteration by the computer system.

• **Main factors**—In developing the design philosophy of the information system, the author points to three major considerations: 1) the time scale of the mission is on the order of months or years, 2) for some part of the time the environment is sub-optimal, and 3) the desirability of employing more sophisticated procedures than blind data-gathering cannot be overemphasized.

Of these, the long time scale is perhaps most vital—in effect, it adds a degree of freedom to the computer design, since the capacity for high speed can be traded for storage capacity.

However, the central computer must monitor its own data-rate requirements. This, Steel asserts, argues for flexibility and militates against a fixed computer program. "Use of a lightning-fast, fixed-program computer as a planetary probe control organ is almost certain to be incorrect."

The one phase of the mission which might require high-speed calculation is guidance, but Steel points out that the braking ellipse approach for the Mars landing takes several hours, obviating the need for nanosecond logic and wired programs.

According to the author, the important result of a no-high-speed requirement is that contemporary logical design and current components can be used. "Existing solid-state components such as diodes, transistors, and cores are relatively gross and not very sensitive to particle radiation—in particular they are not prone to permanent damage as a result of ionization tracks. This situation no longer prevails for the microminiaturized components seemingly necessary for extremely high speeds. Thin films and other products of molecular electronics technology are liable to give considerable trouble after months in space unless protected, and the high energy of cosmic radiation precludes adequate shielding."

In addition to radiation hazards, Steel asserts that most thermal problems can be mitigated by combination of proper skin finishes, component encapsulation, internal shielding and insulation, and compensating thermal-sensitive servos.

• **Limitations** — Discussing fundamental constraints in communication over interplanetary distances which affect the information-processing system design, Steel lists three major limitations: 1) maximum information rate, 2) lag time for signal transit, 3) periodic blackout.

According to Steel, studies have shown that with a 250-ft.-dia. antenna on Earth, 100 kilograms of equipment on Mars will provide just over 100 bits per sec. While some improvements may be made in this area, the order of magnitude of this rate in application is not likely to change significantly in the next decade, he says.

To safeguard this small information capacity, Steel asserts that "all redundancy not immediately related to reliability considerations must be eliminated from the encoding scheme. Indeed, many encoding schemes may be employed, the choice being dictated by the nature of the data. The best solution

THE THREE-DAY Fall Joint Computer Conference in Philadelphia reportedly attracted a record conference attendance of 8000 persons. This included registrants for the 30 technical sessions and visitors and exhibitors at the accompanying hardware display. Attendance at last year's conference was 5000 persons.

Included in the equipment display, valued at about $10 million, were 14 complete and opertaing computer systems. Details of four new computers were also revealed at the meeting. These included Control Data Corp.'s 3600 computer system, the D825 modular data processing system developed by Burroughs Corp., the SOLOMON parallel network computer developed by Westinghouse Electric Corp., and English Electric Co., Ltd.'s KDF.9 computer.



## . . . challenge . . .

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Consider these added values of a career with CHRYSLER Corporation SPACE Division:

- Association with top technical minds.
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If you have engineering experience in research, preliminary design, test or development in the areas of AERO and ASTRONAUTICS, ELECTRONICS, SYSTEMS, LIQUID PROPULSION, STRUCTURES, or ANALOG and DIGITAL COMPUTATION, send your resume in confidence to Personnel Department, P.O. Box 26018, New Orleans 26, La.

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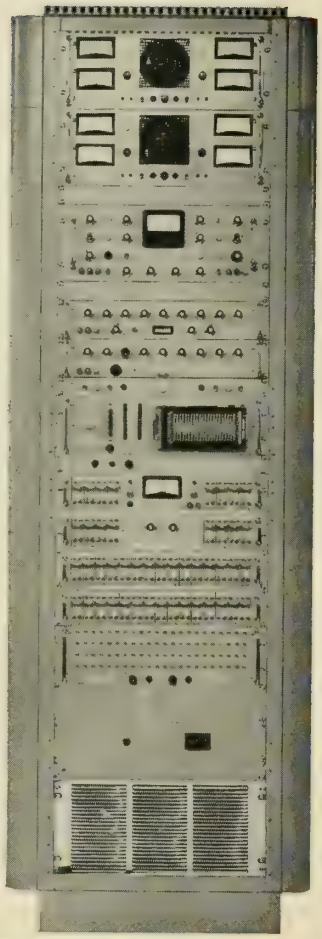
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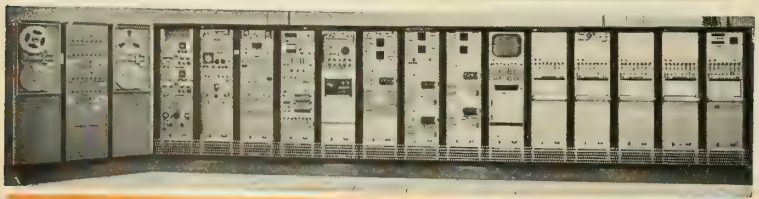
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ARNOUX'S SERIES TDS 300 —

**PROVEN RELIABILITY IN TELEMETRY DECOMMUTATORS**

Arnoux's PAM, PDM, PAM/NRZ Series TDS 300 decommutator offers improved reliability, improved packaging design, and greater operating ease through less-critical adjustments. Arnoux decoms are widely used and known around the world. Arnoux's telemetry instrumentation and components are backed by an established, solid reputation of leadership in decommutation-equipment design and manufacture. The TDS 300 features an input of from 0.5 to 60 v peak-to-peak . . . switch-selected, standard IRIG pulse rates; optional nonstandard PAM, PDM, PAM/NRZ pulse rates from 5 to 3600 pps . . . automatic compensation for commutation-rate change of up to 40 percent; manual compensation up to 80 percent . . . unaffected by SCO dc-level shift and discriminator-frequency zero shift without use of servo (within limits of discriminator pass band) . . . output-signal slope-off of 0.00005 percent/msec of frame (for 5 to 3600 pps) . . . accessory electronic gain and zero servo provides essentially drift-free operation. Shown below: an Arnoux, completely-assembled, 17-rack, telemetry data-acquisition station at a major installation. Five TDS 300's are included, as well as receivers, discriminators, tape recorders, pen recorders, galvanometers, and test equipment.





ARNOUX

**ARNOUX CORPORATION**
(a subsidiary of The Electrada Corporation)
11244 Playa Street, Culver City, California

to this problem seems to be to allow the processing system to select its own encodings, dynamically, as the circumstances require, with a capability to transmit descriptions of the encodings prior to their use in actual data reporting."

Outlining the many technological (due to the 23 light-minute round-trip time delay) and economical problems in developing systems able to respond to new real-time data collection possibilities on Mars, Steel suggests that "inclusion of sufficient circuitry to accept complicated modifications in real-time for the instrument program is not a satisfactory solution to the problem." The best known way of achieving a profitable compromise, he points out, is with an on-board computer containing a highly flexible program.

• **Four demands**—Steel breaks down the information-processing requirements of a probe into four general areas: 1) guidance, 2) data reduction, 3) decision-making, and 4) message-handling.

For guidance, precision dictates a reasonably long word length—about 48 bits—to eliminate or at least reduce multiple-precision calculations. A study of this would be valuable, he asserts, due to the expanse of world-length in terms of circuitry.

Data reduction requires nothing over and above the guidance demands. High-capacity serial storage is needed. Already available miniature magnetic tape systems are adequate. There is no requirement for ultra-high-speed data rates and very rapid start-stop acceleration.

The decision-making and message-handling aspects of the system require bit and byte arithmetic and a full complex of logical instructions. The programing of decision-making, according to Steel, calls for the logical capability of an associative store, but the absence of the need for high speed suggests that a programed associative store will do.

The cost in mass of adding a hardware capability for associative storage is not necessary. "The kind of decision-making envisioned is the type currently being studied in investigations of heuristic programing. What is needed is an adaptive system that is able to adjust to variations in the environment. Pursuance of a study into the nature of such a program might well be more fruitful than some of the current investigations into heuristic programing."

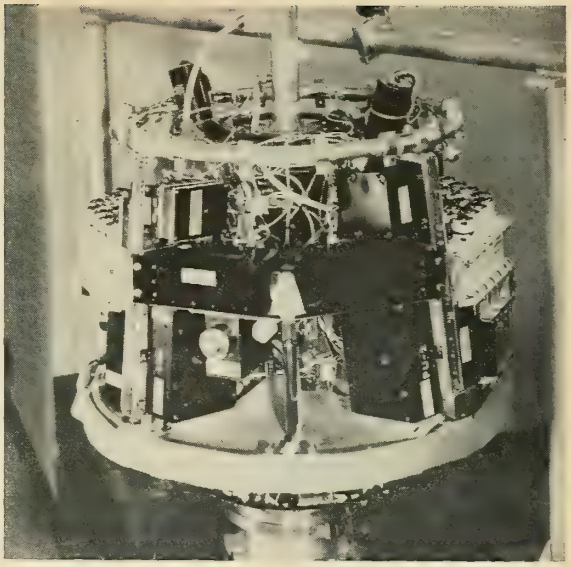
In addition to byte arithmetic, table lookup instructions are vital for message handling, or message composition, according to Steel. Considerable care, he notes, must be used in designing instructions so that random-access storage requirements are not too high. ⁂



Circle No. 11 on Subscriber Service Card

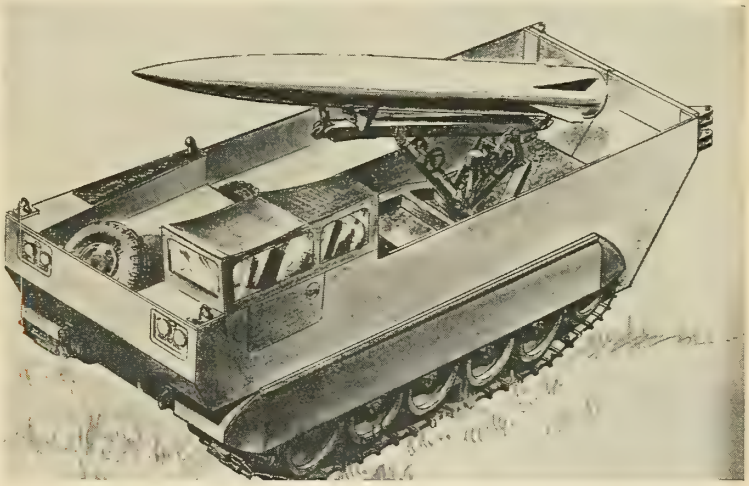


*INSTALLATION of first operational Titan II ICBM in its 155-ft.-deep silo at Davis-Monthan AFB. The missile is lowered onto its blast ring in two stages.*



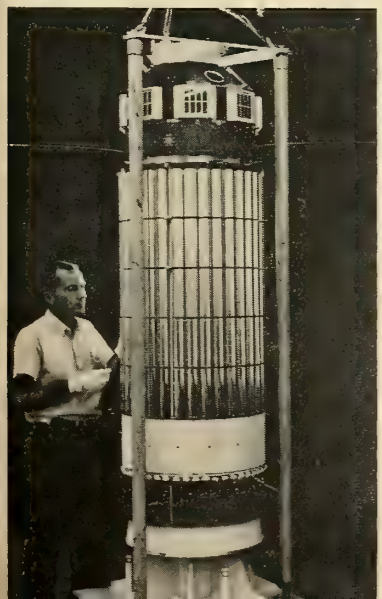
*RELAY SPACECRAFT quadrant (see p. 13) contains 4080-mc beacon, command control box, telemetry encoder, detector and traveling-wave-tube power supplies.*

# News in Pictures



*LANCE, Army division-support weapon being developed by Chance Vought, shown mounted on a fully tracked armored vehicle. Its erector-launcher, also shown, is air-transportable, making the missile highly mobile.*

*S-55 MICROMETEOROID satellite readied for acceleration tests preparatory to an actual launch by Scout booster. It is equipped with five types of detectors to study impact of high-velocity particles in space (see p. 13).*



*RYAN'S FIREBEE jet target drone recently marked its 400th flight for a ground-to-air firing mission, at White Sands Missile Range, N.M. More than 200 flights have been made within the past year, indicating accelerated use of Firebee by the Army.*





**CONTROL SYSTEMS ANALYSTS FOR DEEP SPACE SYSTEMS STUDIES**

**Important opportunities** now exist at Hughes for specialists in many diverse areas ranging from complex precision systems of established types to studies on systems which will be based on entirely new concepts.

Work will cover preliminary design studies, analysis of systems requirements, performance trade off decisions and configuration planning.

Activities will include servo analyses, computer simulations, error analyses, parametric studies and similar functions.

Three to fifteen years' experience in the same or allied field is desirable. Advanced degree from an accredited university is preferred.

*For immediate consideration, please airmail your resume to:*

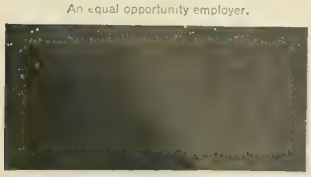
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**Head of Employment**
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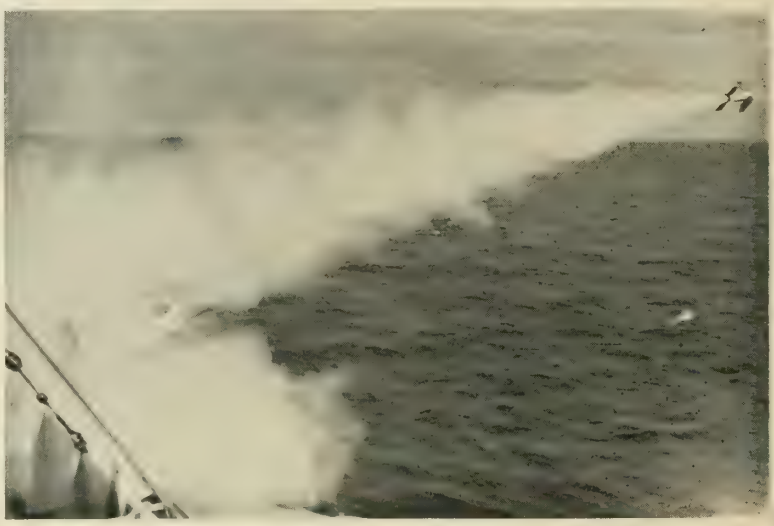
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# Swedish-bought Seacat Has Dutch Fire Controls



*SEACAT ROUND in flight during acceptance trials on board HMS Decoy.*

SHORT BROTHERS & Harland Ltd., of Belfast, Northern Ireland, scored another first in export sales of missile hardware recently when the Swedish ship Sodermanland fired its first *Seacat* antiaircraft missile.

The Netherlands firm Signaalapparaten provided the fire control equipment, marking the first occasion in which a British naval missile system has been integrated with foreign-made subsystems.

*Seacat* is one of Britain's successful programs, having progressed from drawing board to operational service aboard three British Royal Navy warships in less than five years.

The missile underwent an intensive twelve-month firing program, culminating last August, from HMS Decoy at the Ministry of Aviation's guided missile range at Aberporth, Wales.

Six Royal Navy warships—the Agincourt, Aisne, Corunna, Barrosa, Devonshire and Hampshire—are now fitted with *Seacat*. Three of these have operational *Seacat* systems aboard, but only one—the Devonshire—has been publicly identified as being in this category.

In the fire control subsystem manufactured by Signaalapparaten for the Swedish adaptation of the *Seacat* system, a man in an open turret controls a joystick to operate the Visual Director.

When the *Seacat* is fired, it flies into the field of vision of the aimer's binoculars. He commands it by means of a radio link that transmits to the missile demands initiated by use of the joystick.

Once described as a system for use in a "chips down" situation (M/R, June 5, 1961, p. 19), *Seacat* has been given a mission of close-range defense when hostile aircraft have penetrated a naval unit's outer defenses.

The most successful British missile marketed abroad, it is on order by West Germany, Australia and New Zealand, as well as Sweden.

Last year, Focke Wulf G.m.b.H. and Short Brothers entered into an agreement, reportedly worth $85 million, which designated the German firm as local servicing agent for warships fitted with *Seacat*.

Signaalapparaten thus has become the second well-known Common Market nation company to participate in the export sales program of this missile system.

The *Seacat* is 58 in. long and 7½ in. in diameter. It employs infrared scanning and radio command guidance, and both its booster and sustainer are solid-propelled.

Its quadruple launcher is manufactured by Rose Brothers Ltd. ⠿

## Management-Labor Developments

Boeing Co. employees have endorsed establishment of a union shop by a vote of 21,879 to 7752, in marked contrast to similar polls in which personnel of General Dynamics, Ryan Aeronautical and North American Aviation rejected compulsory union membership or payment of union dues.

Though the earlier votes at GD, Ryan and NAA were binding upon all parties, the Boeing tally is termed "only advisory" to the National Labor Relations Board.

After the Boeing results were announced, a company statement urged the President's Aerospace Board not to consider the vote a true reflection of employee views. It charged the union with distortion of the purpose of the poll through "such extremes as indicating that every employee would receive an increase of $500 a year if he voted for the union shop." . . . *Meanwhile, Lockheed and the International Assn. of Machinists resumed contract negotiations at the request of federal mediators, though both the company and the union termed the deadlock "insoluble."* . . . In another development, the Air Force announced a decline in labor stoppages at AF ballistic missile bases. Only 33 man-days were lost in October, contrasted to 324 in September. The steady decline is partly attributed to recent briefings of union officials by top officers of the Systems Division.

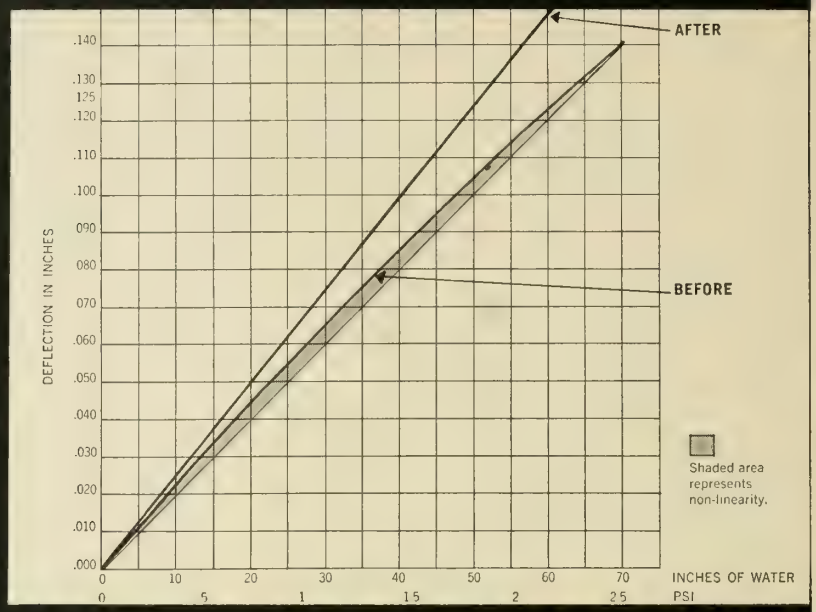
## Industry Facilities

Aerojet-General Corp. is building a multimillion-dollar solid-fuel rocket facility as the first installation on a 75,000-acre waterside site south of Miami. To be built completely with company funds, the installation is expected to be operational by spring of 1964. The facility will do work that cannot now be done at other A-G plants and will not take work away from any other A-G installations. . . . *Deutsch Co., producer of electronic and hydraulic components for missile/space applications, will build a $300,000 facility on a leased site at Los Angeles International Airport. A "buy-back" provision in the lease gives airport authorities option to purchase the facility at close of the lease period, and requires the installation to revert to airport ownership after 20 years.* . . . A 30-acre site adjacent to General Dynamics/Astronautics facilities in Kearny Mesa Industrial Park, San Diego, Calif., accommodates a new 160,000-ft. plant of Ryan Aeronautical Co. The plant, to be operational early in 1963, was acquired by Ryan from Associated Construction Corp., which originally constructed it for lease to Lionel Pacific Corp. This area will bring Ryan's total manufacturing, enginering and administration space at four locations to 1,850,000 sq. ft. . . . *Giannini Controls Corp. will house its Transducer Div. in a modern 54,000-sq.-ft. plant adjacent to corporate headquarters in Duarte, Calif. To be ready by next June, the facility will provide a 30% increase in working floor space, as well as ample property—4.6 acres—for future expansion. This move, part of a geographic centralization program, is expected to shorten the program by a full year, compared to Giannini's original schedule. The firm's Transducer Div. is now located in Pasadena, Calif.* . . . Wyle Laboratories has leased a building adjacent to its El Segundo, Calif., facility, adding 12,000 sq. ft. to its assembly area. Main function of the addition is to handle expanded production of electronic power-aging equipment. . . . *Gertsch Products, Inc., Los Angeles precision electronic instrument manufacturer, has expanded its manufacturing and engineering space by one-third in leasing adjoining plant facilities.* . . . Arco Electronics, Inc., specialized distributor of electronic products, will move its Dallas plant and offices into a new building next February, more than doubling the size of its southwestern regional headquarters. Arco's main office is in Great Neck, N.Y. . . . *Baldwin-Lima-Hamilton Corp.'s Standard Steel Div. has expanded production and quality control capabilities for superalloy forgings by incorporating new and modernized shop facilities. Representing an investment of more than $750,000, facilities include a giant 40-ton forging manipulator, new bottom program-control furnaces and six existing furnaces completely converted to gas/oil firing with automatic program control.*

## Mergers & Reorganizations

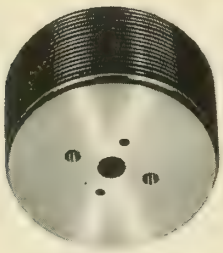
General Control Co.'s operations will be merged with International Telephone and Telegraph Corp.'s U.S. Commercial Group early in 1963. Two years of negotiations were required to bring about the merger. General Controls will continue to operate autonomously in all its locations, and the family team of William, Alvin, John and Richard Ray will continue to administer operations. . . . *Angelus Industries, Inc., has paid about $1 million in cash to acquire the Bellwood Div. of Packard Bell Electronics at Orange, Calif.* . . . Babcock Electronics Corp. has changed the name of its Military Products Div., Costa Mesa, Calif., to Aerospace Div., to describe more accurately the unit's functions. . . . *General Electric has consolidated a major part of its aerospace and defense field service to form a new Aerospace & Defense Service Engineering Dept. under its Defense Programs Operation.* . . . Avco Corp.'s Aerospace Structures Div., Nashville, Tenn., has set up a new Engineering and Development Dept., which will work on reinforced plastic rocket chambers and nozzles.

# Let's Compare Bellows Performance




# BEFORE and AFTER

# Welded Diaphragm Metal Bellows



In a recent performance comparison test conducted in cooperation with a leading recording instrument manufacturer the dramatic "Before" and "After" results showed:

**Before:** The hydroformed bellows deflection with stroke was non-linear by as much as 3½%.

**After:** A welded diaphragm metal bellows designed by Metal Bellows Corporation operating over exactly the same controlled pressure range had a linearity of 0.4% or approximately a 900% improvement.

Of course the improved linearity curve resulted in significantly better bellows output as well as important added bellows life.

Bellows for Bellows you can't find better performance than you get from Welded Diaphragm Metal Bellows!

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# AWARDS

## AIR FORCE

$14,000,000—**Thiokol Chemical Corp.**, Bristol, Pa., for *Minuteman* Stage I solid rocket motors, spare parts and ground support equipment (supplemental contract).

$10,000,000—**Sperry Rand Corp.**, New York City, for instrumentation of C-4 tracking vessels for the Atlantic Missile Range.

$9,000,000—**International Telephone and Telegraph Corp.**, New York City, for work on electronics equipment. Work to be done at Paramus, N.J.

$9,000,000—**Aerojet-General Corp.**, Azusa, Calif., for *Minuteman* solid rocket motors.

$5,500,000—**Martin Marietta Corp.**, New York City, for research and development work on a vehicle for a space program. Work to be done at Baltimore, Md.

$5,000,000—**Hughes Aircraft Co.**, Culver City, Calif., for procurement of long lead time items for *Falcon* missile. Work to be done at Tucson, Ariz.

$4,000,000—**Martin Marietta Corp.**, New York City, for research and development on a space program (supplemental contract).

$3,500,000—**Collins Radio Co.**, Dallas, Tex., for antennas for use at *Atlas* and *Titan* missile sites throughout the United States.

$3,000,000—**Hallicrafters Corp.**, Chicago, Ill., for work on a classified Air Force project.

$2,300,000—**Hughes Aircraft Co.**, Culver City, Calif., for work on *Falcon* missile fire control systems.

$1,798,766—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for modification and provision of launch services for the *Thor* missile (supplemental contract).

$1,600,000—**Radio Corp. of America**, New York City, for work on the Ballistic Missile Early Warning System. Work to be done at Moorestown, N.J.

$1,500,000—**Avco Corp.**, Wilmington, Mass., for additional research and development on nose cones.

$1,265,000—**Hazeltine Corp.**, Little Neck, N.Y., for kits and spare parts for electronic training equipment.

$1,234,850—**American Bosch Arma Corp.**, Garden City, N.Y., for installation and checkout of *Atlas* missile guidance systems.

$1,102,313—**North American Aviation, Inc.**, Los Angeles, for production of spare parts for *Minuteman* guidance and control systems. Work to be done at Downey, Calif.

## ARMY

$20,756,820—**Sperry Utah Co.**, Salt Lake City, for production of the *Sergeant* missile system.

$19,180,625—**Paul Hardeman, Inc.**, Stanton, Calif., in joint venture with the **C. H. Leavell Co.** as sponsor and **Morrison-Knudsen, Inc.**, for construction of Phase 3 of the NASA program at the Manned Spacecraft Center at Houston, Tex.

$10,000,000—**Western Electric Co.**, New York City, for *Nike-Hercules* missile equipment. Work to be done at Burlington, N.C., and Springfield, Ohio.

$4,936,416—**General Precision, Inc.'s Kearfott Div.**, Little Falls, N.J., for additional production quantities of hydraulic actuation systems for the *Pershing* missile (2 contracts).

$3,600,000—**Aerojet-General Corp.'s Aetron Div.**, Covina, Calif., for expansion of rocket test facilities at the Marshall Space Flight Center at Huntsville, Ala.

$3,161,098—**General Precision, Inc.'s Kearfott Div.**, Little Falls, N.J., for production of items for the *Pershing* ballistic missile. Work to be done at Clifton, N.J.

$2,470,966—**Sperry Rand Corp.'s, Sperry Utah Div.**, Salt Lake City, Utah, for the production of nine *Sergeant* missiles general support shop sets.

$2,162,000—**Radio Corp. of America**, Camden, N.J., for continued research and devolpment on multi-purpose test equipment.

$2,000,000—**Radio Corp. of America's Defense Electronics Products Div.**, Camden, N.J., for further development of multi-system test equipment for automatic testing of many Army missile systems.

$2,000,000—**Ford Motor Co.'s Aeronutronic Div.**, Newport Beach, Calif., for continued development of the *Shillelagh* missile system.

$771,720—**Bendix Corp., Red Bank Div.**, Eatonville, N.J., for components for the *Pershing* missile system.

$53,932—**Crocker Co., Inc.**, Burlington, Mass., for providing components for the *Pershing* missile system.

**Leach Corp.**, Compton, Calif., for command receivers for the ARPAT ballistic missile defense system (undisclosed amount).

**Kaiser Engineers**, Washington, D.C., for conceptual studies, preliminary design and detail of the integrated mission control center at NASA's Manned Spacecraft Center, Houston, Tex. (undisclosed amount).

## NAVY

$4,583,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for engineering services on *Terrier* and *Talos* missile fire control equipment.

$1,689,500—**Bell Aerospace Corp.**, Buffalo, N.Y., for supersonic targets. Work to be done at Paris, France and Pt. Mugu, Calif.

$1,169,009—**Whaley and Minter Construction Co., Inc.**, Brunswick, Ga., for construction of a Type I missile magazine at the Naval Ammunition Depot at Charleston, S.C.

$520,000—**United ElectroDynamics, Inc.'s United AeroSpace Div.**, Los Angeles, for transistorized airborne telemetry systems for target drones.

## NASA

$1,240,000—**Alco Products, Inc.**, New York City, for 13 diesel engine pumping units to be used at the George C. Marshall Space Flight Test Center, Huntsville, Ala.

## INDUSTRY

$1,600,000—**Talley Industries, Inc.**, Mesa, Ariz., from **Boeing Co.**, for additional solid propellant ballistic actuators for *Minuteman* missile silos.

$1,500,000—**Talley Industries, Inc.**, Mesa, Ariz., from **Boeing Co.**, for ground support equipment for the *Minuteman* system.

$1,000,000—**Fairchild Semiconductor**, Mountain View, Calif., from **Boeing Co.**, for transistors for the *Minuteman* program.

$1,000,000—**The Electric Autolite Co's C&D Batteries Div.**, Conshohocken, Pa., from **Boeing Co.**, for batteries for the *Minuteman* system.

$1,000,000—**Western Gear Corp.**, Everett, Wash., from **Boeing Co.**, for spring can containers for the *Minuteman* missile system.

**Texas Instruments, Inc.**, Dallas, Tex., from **North American Aviation**, for solid circuit semiconductor networks for use in the *Minuteman* program (undisclosed amount).

**Simmonds Precision Products, Inc.**, Tarrytown, N.Y., from **Beech Aircraft**, for development, manufacture of the quantitive instrumentation systems which will be used to measure supercritical fluids aboard the *Apollo* spacecraft (undisclosed amount).

**Edgerton, Germeshausen & Grier, Inc.**, Boston, Mass., from the **Applied Physics Laboratory of Johns Hopkins University**, for production of a flashing light source for the Navy's All-Weather Navigation Satellites (undisclosed amount).

**Westinghouse Corp.'s Molecular Electronics Div.**, Baltimore, Md., from **North American Aviation's Autonetics Div.**, for microminiaturized integrated electronic circuits for use in the improved *Minuteman* program (undisclosed amount).

**RMS Associates, Inc.**, Mount Vernon, N.Y., from **Grumman Aircraft Engineering Corp.**, for design and fabrication of Stellar Television Monitor Equipment (STME) for the *Orbiting Astronomical Observatory* (undisclosed amount).

# REQUESTS FOR BIDS

## GENERAL PROCUREMENTS

Director—Atlantic Div.
Bureau of Yards and Docks
U.S. Naval Training Station
Norfolk, Va.

*Polaris* training building (third increment). Fleet anti-air warfare training center, Dam Neck, Virginia Beach, Va. Job—IFB NBY 46669. Bid opening 12-28-62.

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National Aeronautics and Space Administration
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Negotiations will be conducted with Donner Div., Systron Donner Corp., Concord, Calif., for accelerometers—14 each. RFP C-79702. Note: For information only, RFP not available.

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Hercules Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

The U.S. Army Missile Command proposes to procure from Microwave Tube Div. of Hughes Aircraft Co., Los Angeles, Calif., overhaul of backward wave oscillators for the *Nike-Hercules* missile system. All inquiries relative to this procurement for subcontracting possibilities are to be directed to the Microwave Tube Div., P.O. Box 90427, Los Angeles 45, Calif.

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Procurement and Production
Base Procurement Div.
L. G. Hanscom Field
Bedford, Mass.

Probe, langmuir type, for the measurement of electron density at high altitudes of a disturbed ionosphere—2 each. Request for Proposal, Purch. Request No. CRL-0997. Single source to be negotiated with Geophysics Corp. of America, Bedford, Mass. Note: For information purposes only. RFP not available.

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Procurement Office
White Sands Missile Range, N.M.

Magnetic tape recorder/reproducer. Delivery to White Sands Missile Range, N.M.—2 each. IFM AMC(R)-29-040-63-36B. Bid opening 1-10-63. Bid sets available through 12-27-62 unless sooner exhausted.

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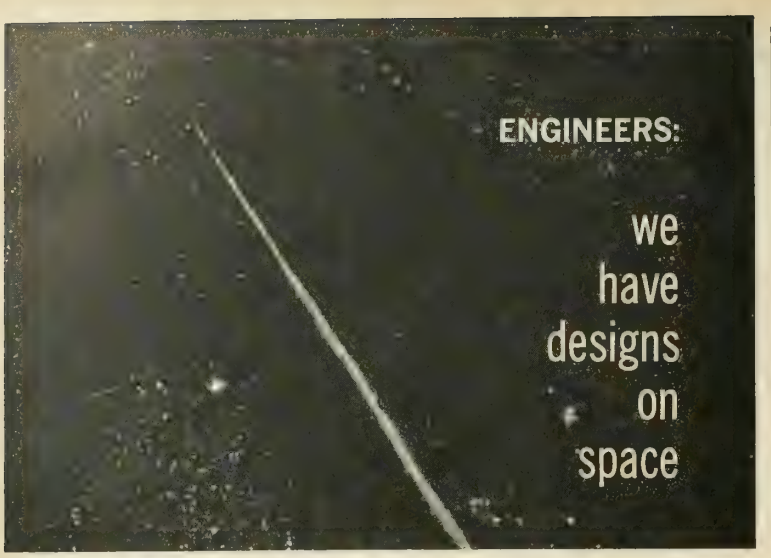
U.S. Navy Dept.
Bureau of Ships
Washington 25, D.C.

The Bureau of Ships under RFP SP24-1101-1(S) is soliciting a proposal from Sperry Gyroscope Co., Marine Div., Syosset, L.I., N.Y., for the manufacture of supporting test equipment for inertial navigation systems and subsystems. This firm has previously performed work on this project and has the data and knowledge to perform the work and to meet the military requirements of this procurement. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.

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U.S. Army Missile Command
Redstone Arsenal, Ala.

The *Nike-Zeus* project office, Army Materiel Command, through the New York Procurement Dist., proposes to award a contract supplement to Western Electric Co. for continuation for providing and firing probes to support operation "Fishbowl". The proposed date for contract award




**Immediate openings exist for specialists experienced in**

# DESIGN ASSURANCE and RELIABILITY

Specialists, including top-level supervisory and individual contributors at all levels of professional and academic achievement, are needed for activities in Reliability Control Engineering, Engineering Parts Control, Project Reliability Groups and Project Design Review Groups.

Tasks involve **TECHNIQUE DEVELOPMENT** in the following:

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## COMPONENTS:

Reliable Hardware Design, Hardware Analytic Evaluation, Component Test and Evaluation, Parts and Materials Selection, Specification Criteria, Supplier Evaluation.

## DISCIPLINES:

Reliability and Maintainability, Human Factors, System Safety, Value Engineering, Mathematics and Statistics.

## MANAGEMENT METHODS:

Design Review, Task Progress Control, Organization and Work Flow.

**All positions require minimum of a BS degree; quality control experience is not applicable. To obtain full information concerning these and related opportunities, or to arrange an early interview in your area, write in confidence to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5792 Kearny Villa Road, San Diego 12, California.**

AN EQUAL OPPORTUNITY EMPLOYER

GD

**GENERAL DYNAMICS**

**ASTRONAUTICS**

is 1-5-63. Competitive solicitation is precluded because of the continuing nature of the development effort. This synopsis is to publicize possible subcontracting opportunities. All inquiries relative to subcontracting must be directed to Western Electric Co., 222 Broadway, New York 38, N.Y.

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Procurement Office
White Sands Missile Range, N.M.

Pre-amplifiers, wide band type, 1-2 KMC—2 each; 2-4 KMC—2 each; 4-8 KMC—2 each; 8-12 KMC—2 each. Delivery to White Sands Missile Range, N.M. IFB AMC(R)-29-040-63-35B. Bid opening 1-11-63. Bid sets available through 12-28-62 unless sooner exhausted.

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Officer in Charge
Navy Purchasing Office
929 S. Broadway
P.O. Box 5090
Metropolitan Station
Los Angeles 55, Calif.

Selected source procurement with Rocket Research Corp., Seattle, Wash., to conduct experimental investigation into the combustion characteristics of a new concept in hybrid rocket propulsions. Proposed procurement involves proprietary data and equipment, available from no other source. Services for Naval Ordnance Test Station, China Lake, Calif. This procurement synopsized for information purposes only. RFP not available.

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U.S. Army Electronics Materiel Agency
Ft. Monmouth Procurement Office
Ft. Monmouth, N.J.

Award is being made to Motorola, Inc., Chicago, Ill., to continue research and development work in the field of data transmission investigation. Contract is in the process of being awarded; therefore, no other offers will be considered.

---

National Aeronautics and Space Administration
Wallops Island Station
Wallops Island, Va.

500 KCS magnetic tape recording systems—2 each. IFB P-605. Bid opening 12-19-62.

---

Directorate
Procurement and Production (SAPOS)
Kelly AFB, Tex.

1730-859-5362 (P/N 1081-52-1) link assembly—18 each; 1730-859-5343 (P/N 106024-503) manifold assembly—22 each; 1730-859-5363 (P/N 108152-2) link assembly—17 each; 1730-859-5372 (P/N 108066-3) clevis—49 each. Applicable missile trailer P/N 107242, Model 6200. Drawings and specs are available. Deliver to Transportation Officer, Kelly AFB, Tex. IFB 41-608-63-338 (B). Bid opening 12-31-62. Direct inquiries to E. A. Nash, WAlnut 3-5411, Ext. 64156, Kelly AFB, Tex.

---

National Aeronautics and Space Administration
NASA Flight Research Center
P.O. Box 273
Edwards, Calif.

Voltage controlled oscillators. Requests for proposals should be received within five days after publication of this synopsis. Request for copies of RFP will be on first-received, first-served basis to the extent available. Various quantities. RFP PR-1624. RFP due date 1-4-63.

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Chief
Bureau of Ships
Department of the Navy
Washington 25, D.C.

The Bureau of Ships under RFP 603-18186.3 (S) is soliciting a proposal from Vitro Corp. of America, Silver Spring, Md., for the furnishing of weapon systems engineering services for various classes of guided missile ships. This is acceleration of work which this firm is presently performing for the Navy. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm.

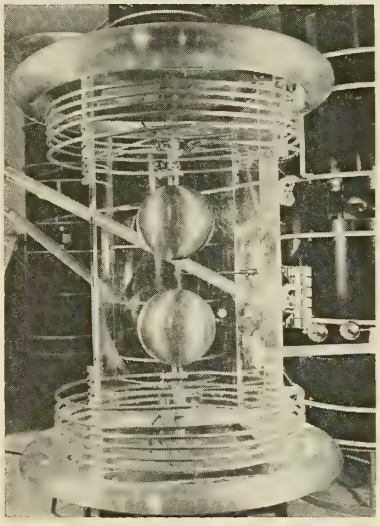
## New Product of the Week:

## Electronic Crowbar

An electronic crowbar using the needle-triggered arc-gap technique provides infinite voltage range fault-current diversion with power supplies up to 230 Kv. The new crowbar, designated Model 108A, is designed and manufactured by Radiation at Stanford, a subsidiary of Radiation Incorporated.

Used with Radiation's Model 101A crowbar logic circuit, the 108A gap can place a short on the power supply within two microseconds. The needle-trigger design permits reliable triggering action over the entire operating voltage range of the system without any mechanical adjustment or loss in triggering speed.

A multiple fire adapter prevents recharging of the capacitor bank between initial crowbar firing and removal of primary power supply. The adapter relights the arc at four millisecond intervals for 56 milliseconds. The unit stands 75 in. high and is designed for floor mounting. Usual installation is adjacent to the power supply being protected. The trigger pulse transformer furnished with the gap is included in the basic system as a separate item for maximum installation flexibility.



Circle No. 225 on Subscriber Service Card

## Waveguide Stand

A rigid, non-magnetic, adjustable support for laboratory microwave systems is available from Orbitronics, Inc. The support is designed to facilitate rapid alignment of system components on a center-line. Standard support and clamping fixtures afford complete mounting flexibility in horizontal and vertical planes, while eliminating the usual conglomerate assortment of such mounting devices as blocks, jacks, C-clamps, rods, movable stands and special supporting brackets.

The rigid base assembly will support several vertical levels, and yet is light enough to permit movement of complete sections without changing component alignment.

Circle No. 226 on Subscriber Service Card

## Wind Vector Indicator

A Wind Vector Indicator marketed by Flow Corp. is a single instrument for continuous readout and recording of the instantaneous magnitude of all three components of wind force: North-South, East-West, and up-down.

The Dynamic Wind Vector Indicator uses a one-foot sphere as a transducer. The sphere contains a three-component flexure force balance. There are no external moving parts and all the circuitry is solid state. Output is a variable d-c voltage on each axis suitable for use with most common XY recorders or computer inputs. Frequency response of the system is 12 cps.

The angular range is 360° in the horizontal plane and ±60° from horizontal in the vertical plane. Gust sensitivity is less than 1 ft. at 15 knots, less at lower velocities.

Circle No. 227 on Subscriber Service Card

## Double-Ended Blower

Developed by Globe Industries, Inc., a double-ended d-c blower uses the new Globe type GRP permanent-magnet motor as a power source to develop 110 cfm at free air to shut-off at 3.1 in. of water. The blower is designed to operate at 10,000 RPM on 27.5v d-c with a minimum life of 1,000 hrs. at 55°C. It is qualified to standard MIL environmental specs.

Circle No. 228 on Subscriber Service Card

## Automatic Particle Monitor

Developed by Royco Instruments, Inc., a built-in, controllable air-dilution system in the Royco Model 202 Automatic Airborne-Particle Monitor enables atmosphere monitoring ranging from the cleanest clean room to the most highly contaminated environments. Air-dilution facilities are variable from 0 through 50-to-1 dilution. With this unit, particle size readings can be programmed over any desired combination of 16 ranges from 0.3 to 10.0 microns. The instrument measures and counts all particles larger than 0.3 in aerosol concentrations from 0 to 150 million particles per cu. ft.

Circle No. 229 on Subscriber Service Card

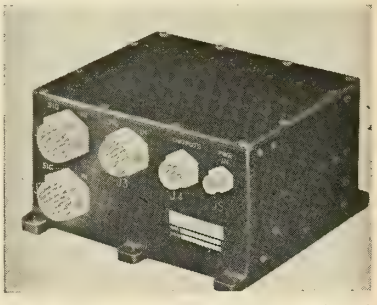
## Ag-Zn Battery

A remotely activated primary silver-zinc battery Model P163A which supplies highly reliable airborne electrical power for range safety systems of space-vehicle boosters is available from Power Sources Div. of Telecomputing Corp. The battery has an output capability of 28v at 15 amps for 20 minutes. Activation time is 15 seconds; activated stand life: up to 12 hours. Special cell design permits battery to maintain a maximum open-circuit voltage of 32v. For short durations, unit can provide pulse currents up to 200 amps. Electric heaters for low temperature operations permit an operating temperature range of −35°F to 160°F.

Circle No. 230 on Subscriber Service Card

## PCM System

Dynaplex Corp. is marketing the type 700 PCM (Pulse Code Modulation). The all solid state design incorporates silicon semiconductors throughout and features low component count for increased reliability and reduced weight, size. The flexible design makes possible the sampling of high level signals varying from 0 to 5 volts and differential low level signals down as low as 5 millivolts full scale in combination or all of the same type. For units with only high level inputs, the sampling rate may be specified from 0 to 50,000 samples/second. For units with low or mixed level inputs, the rate is limited from 10 to 25,000 samples/second.



Circle No. 231 on Subscriber Service Card

## Counter Controller

An all-transistorized 100-kc preset counter-controller has been developed by Computer Measurement Co., Division of Pacific Industries, Inc.

The 770C Series preset counters are designed to solve such control problems as motor overspeed, shearing to length, high-speed coil winding, weighing, sorting, batching, function programming and timing and variable pulse generation.

The unit is a direct-reading solid-state electronic counter providing output information in the form of pulses and relay closures at any preselected count within the capacity of the unit. Capable of totalizing and recycling at rates to 100 kc, the instrument accepts input information from any standard transducer, such as a photocell, tachometer, flow and pressure pickups, switch closures, etc.

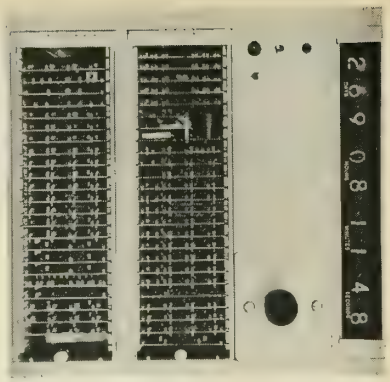
Circle No. 232 on Subscriber Service Card

## Time Code Translator

An all-transistorized universal time code translator, capable of translating any serial time code format presently used at major missile ranges, has been introduced by Astrodata Inc.

The Model 6220 translates either AM carrier codes or d-c level codes to parallel binary-coded decimal form for sampling systems and visual display (long-life, wide-angle, super nixi readout). It provides parallel inputs to a tape search and control unit, both of which Astrodata can also supply for complete universal automatic operation.

Universal operation of the translator is achieved through circuitry which permits the translation of any serial format, and by the use of code adaptor plug-ins which contain only the circuitry necessary to translate a particular code or family of codes.



Circle No. 233 on Subscriber Service Card

## Steam Generator

A compact, high response steam generator capable of producing up to 350,000 lbs./hr. has been developed by The Marquardt Corp.

Primary application for the steam generator system will be providing driving fluid for high-capacity, intermittent-operating ejector systems used in simulating altitude conditions for a broad range of aerospace test facilities, including rocket test stands and wind tunnels. The system also has applications in various processing operations requiring intermittent vacuums.

Circle No. 234 on Subscriber Service Card

## Ionization Gauge

A compact, low-cost hot filament ionization gauge for measuring vacuum from $10^{-3}$ to 2 x $10^{-9}$ mm Hg., in both industrial and laboratory applications is available from the Fredericks Co. The Model 3A was developed to provide the high-vacuum processor with an economical, versatile measuring instrument having sufficient range to cover most industrial and laboratory requirements.

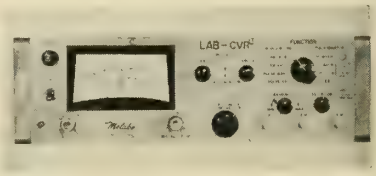
Utilizing a Bayard-Alpert gauge tube, the unit guarantees both amplifier stability and emission stability to be less than 2% over a 24-hr. period Other characteristics of the instrument include linearity of output, convenient resistance degassing voltage stability, and a safety circuit designed to protect the ionization gauge against pressure rise.

Circle No. 235 on Subscriber Service Card

## Microwave Receiver

A microwave receiver is being marketed by MELABS. The LO function can be provided by widely available laboratory signal generators with 1-10 mw output.

LAB-CVR, covering the frequency




range from 500 mc to 11 gc, provides both AM and FM reception. It can be used for microwave monitoring, measuring, spectrum analysis (when the LO is a swept-frequency generator) and as a general-purpose laboratory receiver. Operating range is 95 db (−115 to −20 dbm), AGC dynamite range is 80 db. Typical meter sensitivity is −115 dbm. Measurements of 1000 cycle modulated carriers can be made to −115 db.

Circle No. 236 on Subscriber Service Card

## High-Speed Camera

Red Lake Labs has developed a 16-mm high-speed motion picture camera capable of producing 200 to 6000 pictures/sec.

The Hycam features: built-in event synchronizer and timing light, through-the-lens viewing and on-the-film focusing, an end-of-film motor cut-off switch, film-spool ejectors, static-free operation, design that preserves film ends on run-out, and a full line of available accessories.

Circle No. 237 on Subscriber Service Card


# FREE

## Aero-Space OPPORTUNITIES BULLETIN

*Shows the positions you could have in Aero-Space Technology*

Cadillac Associates, the nation's largest executive and professional placement service, represents the majority of the nation's top companies in Aero-Space engineering. Their best jobs, at salaries from $6,000 to $75,000, appear in our monthly Aero-Space Opportunities Bulletin.

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## new literature

GLASS/EPOXY LAMINATES—A six-page brochure available from Mica Corp. details the complete product line of MICAPLY® standard and thin-grade glass/epoxy laminates available with and without copper cladding of various weights. Specification tables completely detail laminate thickness and tolerances for each grade, plus average properties for each grade in 1/16-in thickness.

Circle No. 200 on Subscriber Service Card

FERRITE SWITCH CORES — Three 4-page specification sheets are available from Electronic Memories, Inc. featuring small, medium and large sized ferrite switch cores. The cores; #101-101 (small), #141-101 (medium) and #181-101 (large) offer good temperature characteristics and are designed for use in switching and current steering applications.

Circle No. 201 on Subscriber Service Card

POWER RESISTORS—A 16-page catalog describing its standard line of precision power resistors is available from California Resistor Corp. The fully illustrated brochure contains specifications and standard ranges-tolerances-resistances for its silicone coated resistors (including non-inductive) for power requirements in advanced electronic circuitry; its metal clad resistors (inductive and non-inductive) for high-power heat sink applications; and its high temperature 350°C silicone-coated resistors (including non-inductive) for high-temperature power applications.

Circle No. 202 on Subscriber Service Card

INCONEL ALLOY 600—A technical bulletin, "Engineering Properties of Inconel Alloy 600," has been released by the Huntington Alloy Products Div. of the International Nickel Co., Inc. The 36-page booklet gives data on composition, physical constants, mechanical properties, metallography, corrosion resistance, applications, working instructions and mill products of Inconel Alloy 600, which is a high-temperature, oxidation and corrosion-resistant nickel-chromium alloy.

Circle No. 203 on Subscriber Service Card

SUPER-SOFT RUBBER—A booklet available from the Roth Rubber Co., demonstrates the resiliency of Roth Super-Soft rubber, and describes a number of defense project uses of this rubber formulation. The booklet shows how Roth Super-Soft can be used as an effectice vibration absorber and noise dampener, as a positive vacuum seal on uneven surfaces and contours, and as an electrical insulator, and also describes the ease of forming, shaping and sizing of the material.

Circle No. 204 on Subscriber Service Card


# How you can avoid three costly mistakes in the selection of a scientific or engineering computer

And the one sure way
to find the computer that suits you best

Selecting a computer can be one of the most important decisions an executive can make. Almost any computer can reduce costs by solving problems, and saving time, but some are far more efficient than others.

This then should lead to a careful study of available computers. And the study must avoid becoming overconcerned with "nuts and bolts" and concentrate instead on overall suitability and purpose.

Basically, the decision has to depend on finding the computer that best serves your needs. The Recomp® line of solid-state scientific and engineering computers has been found ideal for many leading companies. Perhaps it could best meet your needs. The following common mistakes may offer some guidance in your choice.

**(1) "Get the cheapest computer"**

Just as there is no such thing as a cheap pair of shoes, there is no "cheap" computer. Scientific problem-solving computers sell from $40,000 and up. They lease from $1,000 and up a month. But, much more important than initial cost is how much a computer will save you over a period of time.

A computer feasibility study showed that a Recomp computer could save almost $70,000 more than a lower-priced competitor in a year on a given project. In addition, Recomp offers a broad price range. The Recomp III computer is ideal for small-scale needs. And you can lease one for $1,495, complete. For medium-scale needs, Recomp II starts at $2,495. A complete line of peripheral equipment is available for both computers.

**(2) "Buy the fastest one"**

Naturally, speed is important. But computer operating speed is just a small part of the story. Save a few microseconds here and there and you haven't saved much. More important is **total** problem solving time.

The Recomp line of small and medium scale computers mark their savings in terms of hours... not microseconds. Recomp computers can save hours in problem solving time because they're simple to program, easy to operate, and have an exceptionally large memory.

**(3) "Hire specialized computer personnel"**

Not always necessary. Some computers do demand specialized programming personnel to operate them. However, others are so simple to use that engineers can program their problems directly. This ease of programming saves time and increases computer use.

One of the easiest computers to program and operate is Recomp. Engineers with less than eight hours instruction are able to use Recomp computers profitably.

**The one sure way to select a computer**

The computer requirements of every company are unique. The best way to find the computer that fits your own specialized requirements—without making costly mistakes—is through a computer feasibility study. This is the only way to know exactly what computer suits you and your company best.

Put Recomp side by side with any comparable computer on the market. Let the facts speak for themselves. You'll see why no computer feasibility study is complete without Recomp.

We'll be glad to help you get the facts. Write today for a "Management Guide to a Computer Feasibility Study."

**Recomp**

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Please send me a "Management Guide to a Computer Feasibility Study."

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## CHECKING THE POLARIS MISSILE

Designed to process data from 180 channels at one time, a CSC system is now in use at the Sunnyvale, California, thermostructural test facilities of the Lockheed Missiles & Space Division.

Measurements of strain and temperature, recorded at hundreds of points on a Polaris missile being tested, are changed to proportional analog voltages by transducers and processed by the system for digital recording on magnetic tape compatible for direct entry into an IBM 7090 computer. In addition to magnetic-tape recording, output is available in the form of IBM punched cards and X-Y plots. Monitoring is by bar graphs on a 17-inch oscilloscope and oscillograph recordings.

This Thermostructure Recording and Monitoring System is one of hundreds produced by CSC for data acquisition, reduction, conversion, presentation and analysis. In addition to analog and digital data handling systems, CSC designs, develops and manufactures systems for industrial control, electro-optical, pneumatic and hydraulic applications.

For details of CSC accomplishments in your area of interest, call your local engineering representative or write

CONSOLIDATED
SYSTEMS
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# —names in the news—

**Philip Spergel:** Formerly with Mitre Corp., joined the staff of Baird-Atomic, Inc., Cambridge, Mass., as chief engineer.

**E. G. Riley:** Appointed director of advanced planning for the ACF Electronics Div. of ACF Industries, Inc., Riverdale, Md.

**James W. Christian:** Appointed project engineer in the Waveguide Systems Div. of Microwave Associates, Inc., Burlington, Mass.

**Paul G. Krueger:** Named vice president of United-Carr Fastner Corp., Cambridge, Mass.

**David L. Prosser:** Appointed sales manager of nuclear sources for Monsanto Research Corp., Dayton, Ohio.

**John J. Shenk:** Named research and development sales administrator for Raytheon Co.'s Industrial Components Div., Newton, Mass.

**Harold J. Black:** Appointed director of the newly established Engineering and Development Dept. at Avco Corp.'s Aerospace Structures Div., Nashville, Tenn.

**Merton H. Lewis:** Named assistant manager of Eastman Kodak Co.'s government sales div., Rochester, N.Y.

**Richard E. Horner:** Vice president and general manager of Northrop Corp.'s Space Laboratories, elected 1963 chairman of the missile and space council of the Aerospace Industries Assn.

**Dr. Allen H. Keough:** Appointed assistant director of research and development at Norton Co., Worcester, Mass. **Chester N. Pearsall** appointed district product supervisor at the Pittsburgh district office.

**A. Rivoli:** Appointed manufacturing manager of Sperry Products Div. of Automation Industries, Inc., Danbury, Conn.

**Charles K. Knickerbocker:** Appointed Western regional manager for Consolidated Systems Corp., Monrovia, Calif.

**Col. John S. Turton (USAF ret.):** Joined Aerojet-General Corp., Azusa, Calif., as corporate specialist on procurement and material.

**John S. Winter:** Appointed technical director of Sundstrand Aviation Div. of Sundstrand Corp., Denver, Colo.

**George T. Scharffenberger:** Elected senior vice president of Litton Industries, Inc., Beverly Hills, Calif.

**William B. Murray:** Appointed manager of marketing for Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.

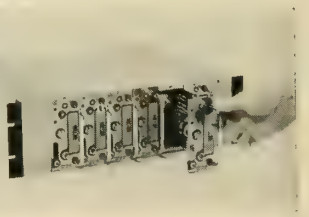

## Voltage and Balance Panel



VB-300 combines three precision monitoring instruments in 3½" of rack space, at less than their usual cost. Digital readout voltmeter provides measurement and setting of bridge excitation voltage to any value between 1 and 20. Bridge output meter permits measurement of static strains in terms of bridge output voltage to any value between 0 and ±100 mv. Null indicator allows bridge balancing within ±10 μv of zero.

Circle No. 15 on Subscriber Service Card

## Transducer Signal Conditioning



Two new transducer and strain gage signal conditioning units feature radically different packaging concept at low cost per channel. Both the PS-290 Power Supply and PB-290 Power and Balance Unit incorporate plug-in card circuits for up to eight channels in a 19" rack, 5¼" high. Bridge completion balancing, and calibration resistors are easily accessible from the front. Output ripple is less than 500 microvolts peak-to-peak, or 200 microvolts RMS. Line regulation is less than 0.02%. Isolation is less than 0.01 microamps of 60 cycle current. Output impedance is less than 0.05 ohm.

MICRODOT INC.
220 Pasadena Avenue
South Pasadena, California
Overseas: MICRODOT AG, Zug, Switz.



Circle No. 14 on Subscriber Service Card
Circle No. 16 on Subscriber Service Card

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# when and where

### DECEMBER

**Structural Dynamics Under High Impulse Loading Symposium, sponsored by AFOSR (Mechanics Div.) and Aeronautical Systems Div., Wright-Patterson Air Force Base,** Ohio, Dec. 17-18.

**Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science,** Philadelphia, Dec. 26-31.

**American Astronautical Society Symposium on Scientific Satellites-Mission and Design,** Franklin Hall, Philadelphia, Dec. 27.

### JANUARY

**Millimeter and Submillimeter Conference, IRE,** Cherry Plaza Hotel, Orlando, Fla., Jan. 7-10.

**American Chemical Society National Meeting,** Cincinnati, Ohio, Jan. 13-18.

**Automotive Engineering Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Mich., Jan. 14-18.

**Ninth Annual American Astronautical Society Meeting,** Statler Hilton Hotel, Los Angeles, Jan. 15-17.

**31st Annual Meeting, Institute of the Aerospace Sciences,** Hotel Astor, New York City, Jan. 21-23.

**43rd Annual Meeting, American Meteorological Society,** New York City, Jan. 21-24.

**Ninth National Symposium on Reliability and Quality Control,** Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

**Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn.,** International Inn, Washington, D.C., Jan. 28.


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American Magazine Group

**Geneva, Switzerland—10 Rue Grenus; Geneva 321044**

**Paris, France—11 Rue Condorcet; TRU 15-39**


**Fourth Annual Solid Propellant Rocket Conference, American Rocket Society,** Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

### FEBRUARY

**Symposium on Engineering for Major Scientific Programs,** Georgia Institute of Technology, Atlanta, Feb. 5-6.

**Electronic Sales-Marketing Assn., First Annual Convention,** Americana Hotel, New York City, Feb. 11-13.

**1963 International Solid-State Circuits Conference, sponsored by IRE, AIEE and University of Pennsylvania,** Philadelphia, Feb. 20-22.

### MARCH

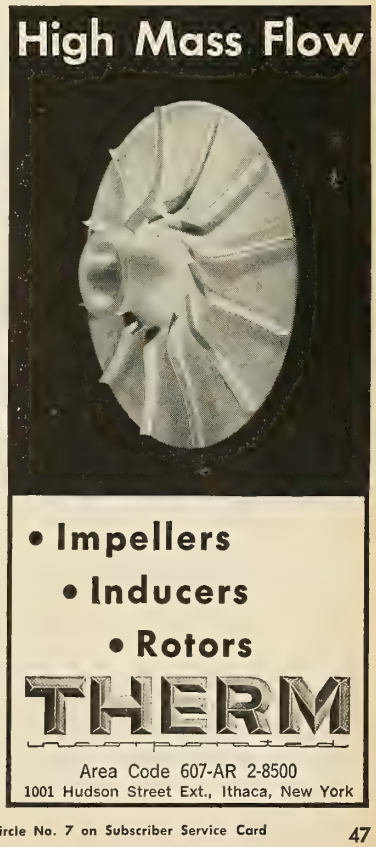
**1963 Microminiaturization Congress,** Sheraton Hotel, Philadelphia, March 5-7.

**Propulsion Meeting, Institute of the Aerospace Sciences,** Cleveland, March 7-8.

**Chemical Engineering in Space Technology Symposium, sponsored by the American Institute of Chemical Engineers,** New Orleans, March 10-13.

### APRIL

**Nuclear Materials for Space Applications Technical Meeting, sponsored by the American Nuclear Society,** Netherland Hilton Hotel, Cincinnati, Ohio, Apr. 17-19.

# Toughest Customer in the World

THE PENTAGON has been called the world's toughest customer. This is both a compliment and a derogation. If one is looking at the demand for efficient, effective hardware, then it's a compliment.

But if the subject is the confusing and often muddle-headed procurement policy of Dept. of Defense and the three services, it can only be considered disparaging.

For years, industry and the military have tried to hammer out a buyer-seller relationship suitable to the climate of today's fast-moving technology. The solution has yet to be found.

The pace of development has accelerated so rapidly that excessive change orders can obsolete a weapon before it becomes operational. The technology has become so complex that production can be as infinitely difficult a task as the original research and development. Programs have become so vast that cost management assumes terrifying proportions.

In the face of these and other difficulties, the Pentagon has been vacillating, indecisive and unoriginal in its approaches to procurement. Halfhearted attempts have been met with the lack of results one would expect.

Secretary of Defense McNamara and his team now are making the strongest effort yet to find a solution to procurement problems. To do this, DOD has taken over from the three services much of the authority and resonsibility for procurement. Despite the ensuing cries of rage and alarm, we cannot sympathize deeply with those who have had authority taken away from them because they declined to use it properly in the first place.

There are dangers if knowledgeable military leaders are completely bypassed in the process, as we have warned before. But at least an effort is being made to improve military procurement and industry can applaud the attempt.

In a recent lecture to the Industrial College of the Armed Forces, publisher C. W. Borklund of *Armed Forces Management* magazine outlined very succinctly for his military audience the industry viewpoint on procurement. We would like to quote here some of the points he made:

• **Profits.** "Profits represent corporate health, the strength to continue to function at maximum effectiveness . . . the customer who does not provide long-range profitability very soon finds himself without an efficient low-cost supplier."

• **Costs.** "It is not profits which government should be concerned about but costs. Clobbering profits is clobbering a fly with a sledge hammer. Costs are what the government shells out and profits, according to most company annual reports, are only about 2 to 5% of that total multibillion-dollar figure."

• **Buying-in.** "Today, there is a flurry of activity to cut price lower and lower. The way this flurry is being applied, it is inviting loft operators into the military field, picking up production contracts for prices that companies with brainpower to do the development in the first place can't touch. This burns the companies most anxious to do a job for the military."

• **Research and development.** "This emphasis on price forces the procurement pattern to run exactly contrary to the military demand today on industry. That is, defense demands more R&D in proportion to production runs but scorns the needs of the companies that build up a capability to provide that engineering talent."

• **Open bidding.** "How much do we encourage creativity when we let a company do a prototype piece of hardware and then pass their drawings around to all their competitors so that everybody gets a chance to bid on a production contract? The prototype developer knows this wipes out most of what he felt he was gaining in going into the prototype development at niggardly profits in the first place."

MR. BORKLUND made two suggestions which would do much to improve effectiveness of the industry-military team. These are not new suggestions from industry. But nothing has even been done to implement them and we commend them to DOD for further consideration.

The first concerns rotation of military officers in and out of projects on the basis of three-year assignments. No major program today moves from the drawing board to operational hardware in three years. More frequently, the figure is five, six or seven years. Military officers should be assigned for the development life of the project. Otherwise, every change in military personnel is a management setback of six months to a year.

The other suggestion concerns the need for after-the-fact briefings of companies which lose contracts. Why did the winner win? Why did the losers lose?

"It's supposed to be an axiom that from your failures you learn how to succeed," said Mr. Borklund. "We don't give industry this benefit. They've got to guess, and in the maze of thousands of military people they can talk to, all with thousands of differing opinions, they can get all sorts of answers on what happened, mostly inaccurate."

This is not curiosity. It is information industry needs to help it do a better job in the future. Such briefings also might incidentally have a beneficial effect on contract decisions.

When DOD has the new procurement ground rules established, the decision-making role presumably will gradually pass back into military hands. This depends on how fast the military learns the new techniques of budget packages and programing.

But the end result could be that the Pentagon will indeed be the toughest customer in the world—in the best sense of the word.

**William J. Coughlin**

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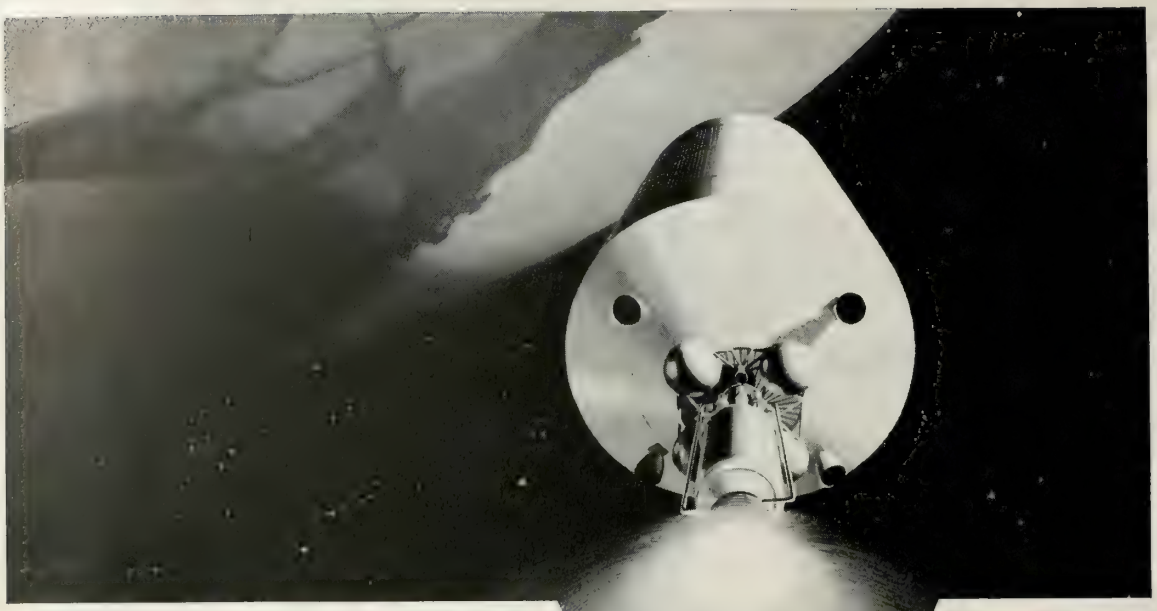
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*Patent Numbers: 2,961,545; 3,007,053; 3,061,730; others applied for.

Barnes Engineering Company

Defense and Space Division

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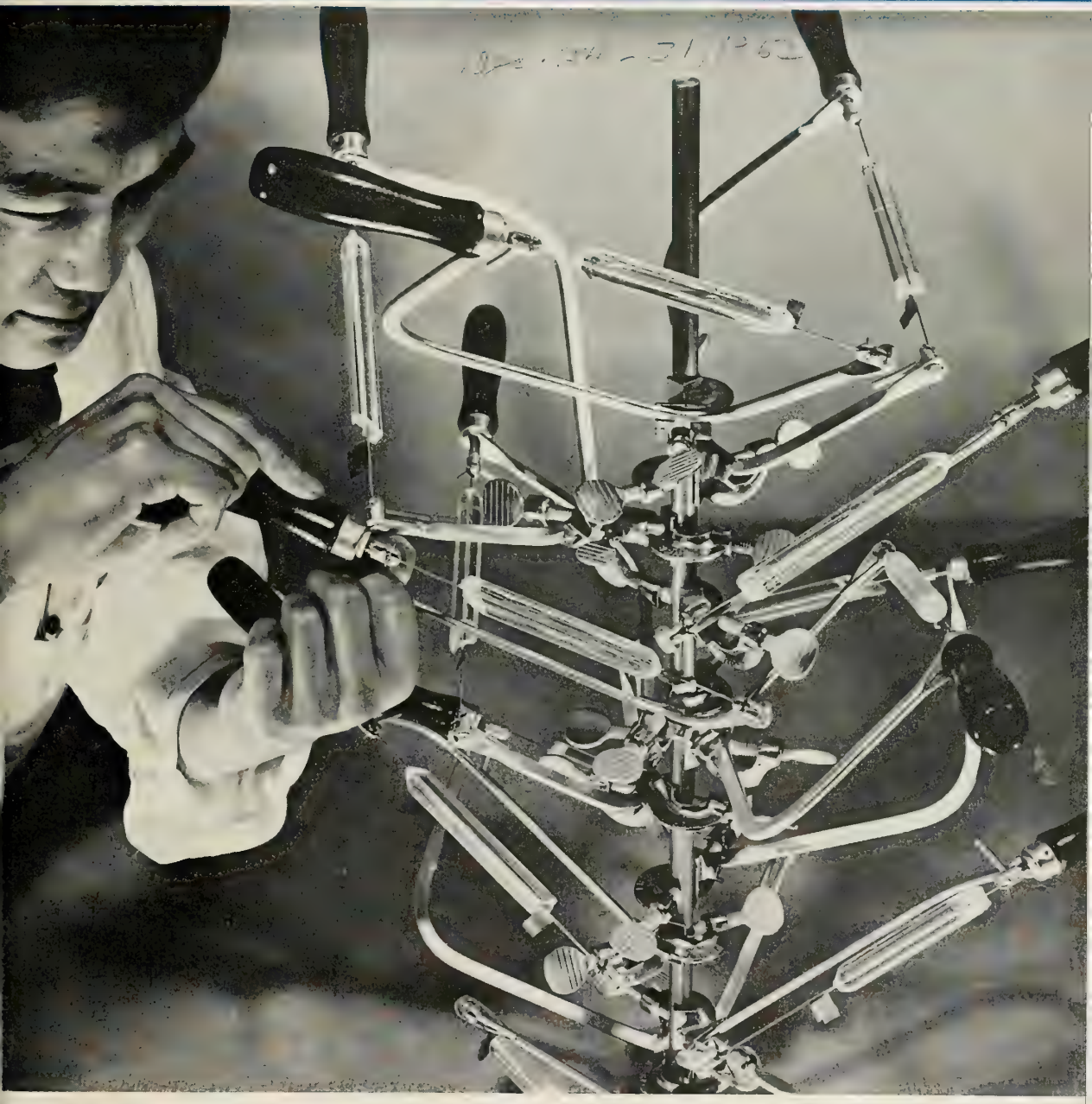
REON
AZUSA, CALIFORNIA

DECEMBER 24, 1962

# missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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**DOD Switches, Calls AICBM Feasible...**

**What Mariner Success Means for '64 ..**

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# MARINER DX RECORD REQUIRED MOTOROLA SYSTEMS RELIABILITY

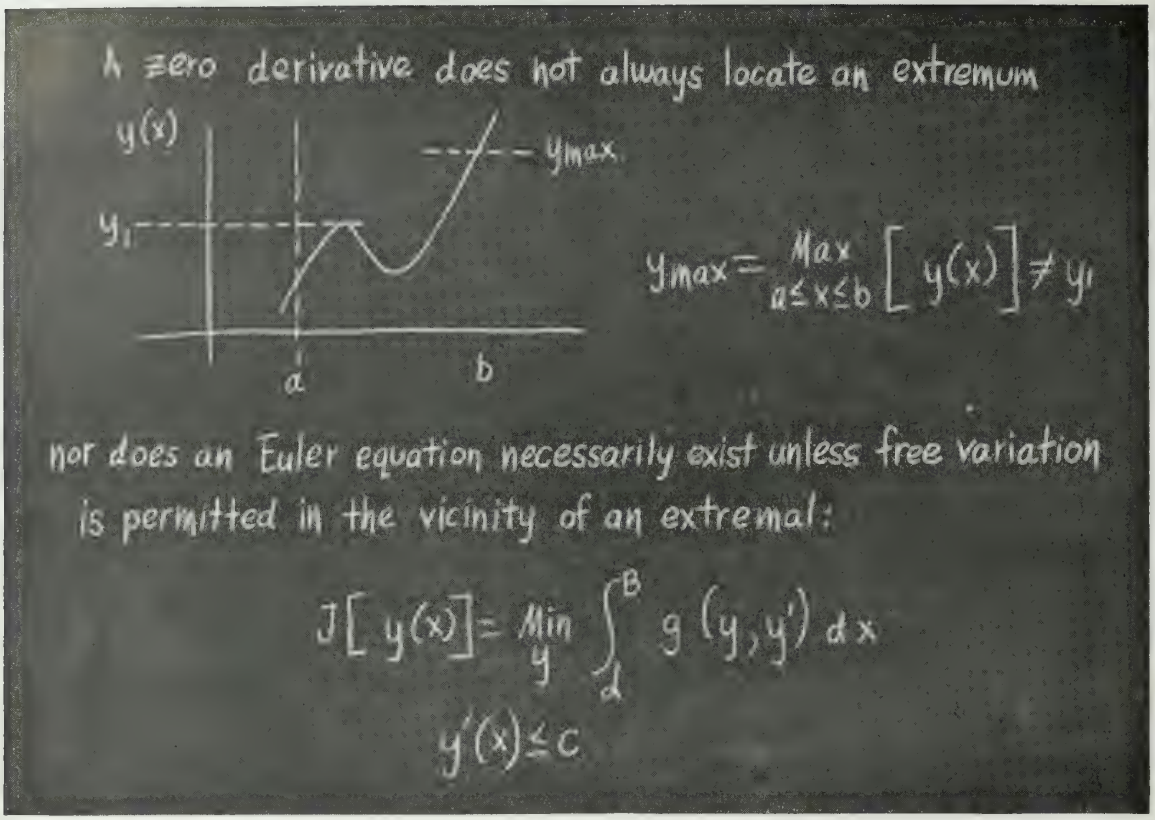


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MOTOROLA

**Military Electronics Division**

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MISSILE & SPACE SYSTEMS DIVISION

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

# missiles and rockets

Volume 11, Number 26 December 24, 1962

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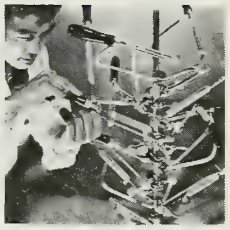
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## THE COVER

*Electro-Optical Systems, Inc., uses taut wires through hardening plastic cylinders to form straight holes that are later filled with experimental laser material. Resulting thin laser rods are used in firm's laser materials research for Air Force.*

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*45,218 copies this issue*

† U.S. Reg. Pdg.

*M/R publishes 51 times a year. Readers are reminded that there will be no magazine on Dec. 31.*

Season's Greetings—The Editors

## Last Word on Ethics

*To the Editor:*

May I commend you most sincerely for saying so clearly and frankly what should have been said long before this on "The Ethics of Fame" (M/R editorial, Nov. 5).

The astronauts undoubtedly have been badly advised.

Perhaps it is not yet too late for them to accept the advice of a wise editor.

For the sake of our space program, let us all hope they do. It seems so unseemly that these fine men with a mission as challenging as any ever faced by mortals, should be so preoccupied with the flighty standards of our materialistic society.

Maxwell J. Seeley
Editor
Wings in Space
Montreal, Canada

*To the Editor:*

I only very occasionally write to an editor in order to comment on an issue under public discussion. However, your editorial seemed to me so shockingly unjust that I cannot keep quiet. Why should your seven astronauts not profit from honorable business opportunities? You should keep in mind that the kind of "Ethics for Heroes" you cite as example was—and still is—established by societies whose leaders expect heroism for nothing but eventually a state funeral.

As a matter of fact, it is much cheaper to pay comfortably one Aristotle that he may persuade a thousand heroes to fight for nothing, than to pay comfortably the thousand heroes.

Fortunately, enough other writers share my opinion (M/R, Nov. 19 & 26), and have expressed their views in more detail. Please take my modest contribution to this issue as that of a European.

W. R. Ruston
Brussels, Belgium

*To the Editor:*

Leave us have done with all this Ethics of Fame flap. El Conscripto, Poet of Cislunar Space, offers the following death-defying lines to bring it to a well-deserved end.

"Guano Republicano"
or
"On First Looking into Coughlin's Boner"

Long have I sojourned in the Land of Brass,
Covered short-sales with margin in Market Coups Crass,
Ran booze thru Ole Miss'—pulled slots in L.V.
In bootless pursuit of Securitee . . .
Yet ne'er of great wealth to be had did I wot,
From levitation in orbit (as by astronaut)
'Til Coughlin (of Virtues—a quorum)
On the "Ethics of Fame" from M/R's Forum
Spoke, and in apostrophe lyrical,
Reminded the Eagles their reward was chimerical.
Doodle, doodle, do. Or much ado about nothing!

Joaquin Molinero el Conscripto
Canoga Park, Calif.

## What If Not Jupiter?

*To the Editor:*

The item titled "What to do with Turkey Left-Overs?" in the COUNTDOWN (M/R, Dec. 3, p. 7) requires considerable amplification and clarification.

The item indicates that obsolescing *Jupiter* missiles may be withdrawn from Turkey. The idea of obsolescence implies that there is something better to replace the obsolescent item. The question then comes to mind: WHAT would replace the *Jupiter* in Turkey?

The item also states that the IRBM's are no longer needed in Turkey. This generates another important question: WHY are these missiles no longer needed there?

Other information indicates that one reason the missiles in Turkey may be withdrawn is that they cannot perform their mission unless personnel training, maintenance and supply services are extensively improved. Such improvement does not appear to be forthcoming.


RUCKER

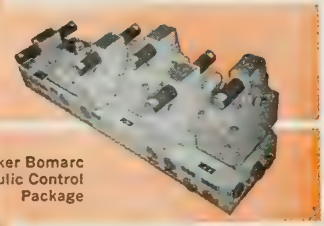
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From all of the above, one might conclude that the American public has been led once again to believe it has had protection which in reality it did NOT have. If this is true, then the public should be awakened before it finds itself without ANY protection!

I hope that you have reliable information which will permit you to appraise the situation and give the true picture to M/R readers and to the American public as well.

(Name Withheld on Request)
Rosemead, Calif.

## AIAA Birth Pains

*To the Editor:*

The letter in the Dec. 3 M/R from Messrs. Kallis and Isbell regarding the ARS-IAS merger deserves some comment.

As an ARS member of fairly long but intermittent status, I fail to see that the letter of Kallis and Isbell has served any useful purpose.

It states that the writers, as members, failed to receive ballots from the American Rocket Society regarding a merger betwen ARS and the Institute of the Aerospace Sciences. The letter writers further state that they "were publicly against" he merger, and they propose a poll "to see what percentage of these opposed (and in favor) of the scheme failed to receive ballots."

Viewed by only a member of ARS, the main purpose of the merger was to provide a broader availability of papers on the state of the art of space science to members of both organizations. Such a scheme benefits many individuals in both organizations as well as many who may become contributory on reading the journal that will result from the merger.

Frank M. Cameron
Member, ARS
Huntsville, Ala.

## Government and Profits

*To the Editor:*

We congratulate you on your excellent Dec. 10 editorial, entitled "An Objective View." We felt it was very well stated and we heartily endorse the contents. We are continually faced with Government employees who feel it is their prerogative and their duty to force the reduction of profits in industry and do not comprehend the importance of this facet to the continued growth and development of private industry.

Gordon T. Ersted
Dayton, Ohio

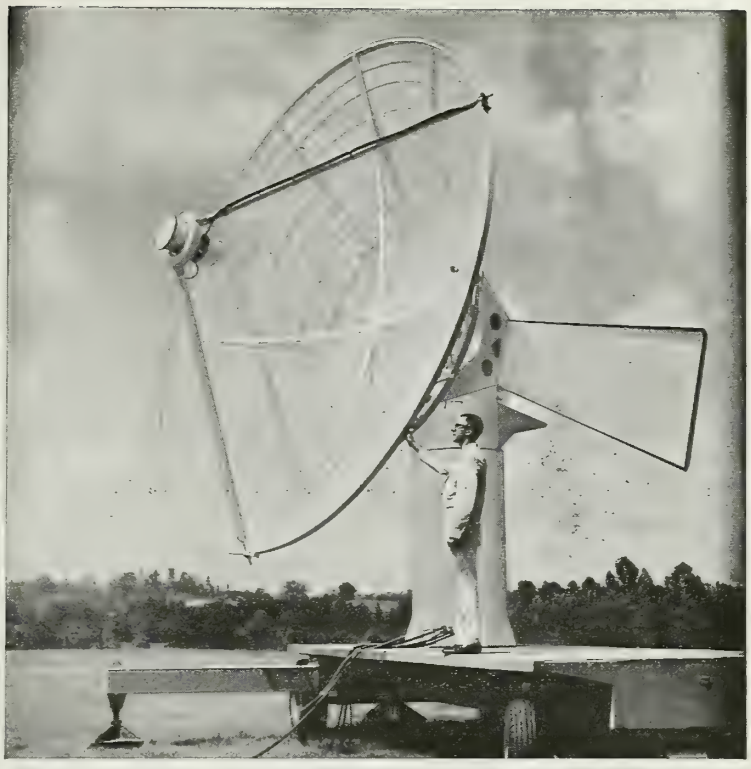
## Lockheed Strike

*To the Editor:*

I have read your Dec. 3 article ("A Stag at Bay") and I am in 100% agreement with you on this matter.

You have the nerve to stand up and say the things that were on the minds of many aerospace employees from production workers through management.

Russell W. Post
Wichita, Kan.

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# The Countdown

## WASHINGTON

### Navy Working on New Condor Missile

Preliminary work on *Condor*, an air-to-surface missile with television terminal guidance, is being done by Naval Ordnance Test Station, China Lake, Calif., and several potential contractors. Navy officials are pessimistic about chances of funding the program in Fiscal '64, however. The missile is seen as a sort of long-range *Bullpup*. Its range is set at 40 miles in preliminary estimates. *Condor* would follow a ballistic trajectory but would have aerodynamic surfaces for terminal control. Pilot of the launch aircraft would have time to command at least three terminal trajectory changes on the basis of his TV picture.

### Air Force Antitank Missile Studied

Air Force has let a study contract to North American Aviation for an antitank weapon, designated *Missile S*. Value: $35,000. Contract was let by Detachment 4 of Aeronautical Systems Div. at Eglin AFB, Fla.

### New Job Shuffle at AFOSR

Resignation of Dr. Knox Millsaps will be followed by a job shuffle at the Air Force Office of Scientific Research. Millsaps is executive director of AFOSR as well as chief scientist of the Office of Aerospace Research. Following his departure, the two jobs will be manned separately. The decision to split the two positions was one of the factors in the resignation of Millsaps, which takes effect in January.

### NASA To Seek New Battery for Space

NASA expects to solicit proposals in the near future for development of a new battery to power spacecraft and satellites. The space agency wants to sponsor development of an organic battery which will have a better energy-to-weight ratio than the current nickel and silver-cadmium batteries.

### Proposals for C-5 Crawler Are Due

Proposals for the *Saturn C-5* crawler-transporter are due at NASA by Jan. 15. The vehicle will haul the booster from its checkout hangar to the launch pad. Twenty-two firms attending a pre-proposal briefing on Dec. 17 were informed that a contract for the crawler would be signed on or before March 1.

### New SAINT Contracts Are Expected

Industry sources report that three study contracts for an advanced *Satellite Inspector* program (M/R, Dec. 10, p. 14) will be let shortly by the Air Force. Designated Program 706, the advanced *SAINT* replaces the earlier 621A program, reoriented following development troubles.

### Mid-Course Maneuver Due for Soviet Probe

If the 2000-lb. Soviet Mars probe is to come anywhere near the planet, a mid-course guidance maneuver will have to be made shortly, according to U.S. calculations. One Soviet report indicates pictures of the Martian surface may not be relayed back to Earth until the probe returns to the vicinity of this planet in a year to 18 months.

### House May Probe Troubled Ranger Program

Investigation of the lagging *Ranger* program by a House space subcommittee is expected to open shortly after Congress convenes next year. It will be headed by Rep. Joseph E. Karth (D-Minn.), who was chairman of the *Centaur* investigation during the last session.

### Flight Program Sought for Power Units

NASA's Office of Advanced Research and Technology is hopeful of eventually activating a flight-test program for space power packages. There is no money in sight for this, however, in either the Fiscal '63 or '64 budgets.

## INDUSTRY

### Bendix ComSat Resembles OAO

The Bendix Corp. entry in the Dept. of Defense 24-hr. communications satellite competition (M/R, Dec. 10, p. 15) closely resembles the *Orbiting Astronomical Observatory (OAO)* designed by Grumman. Bendix project is in the mock-up stage.

### Flights to Start in X-15 Follow-On Program

First flights in the *X-15* follow-on program are set for late next month or early in February. The No. 1 *X-15* has been returned to NASA Flight Research Center, Edwards AFB, Calif., from North American Aviation after four months of modifications for the follow-on program. These include installation of a window in the underside of the fuselage with a camera mounted inside the structure to study optical degradation resulting from observations through hypersonic boundary layers and shockwaves. The program is expected to add 35 flights to the schedule originally set for *X-15* research objectives.

### Site for Moon Rocket Under Preparation

Work at the Merritt Island annex to Cape Canaveral, which will be the site of the *Apollo* lunar launch, is progressing rapidly. Equipment of the Gahagan Dredging Co. of Tampa is pumping millions of cubic yards of fill into the area and digging canals to permit barge transportation of *Saturn* segments to the Complex 39 assembly areas.

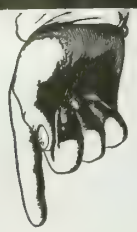
### New Launch Facilities Ready for Samos, Midas

Step-up in launches of the *SAMOS* and *MIDAS* spy satellites can be expected with completion of two additional *Atlas-Agena* launch pads at Point Arguello, Cailf. Designated as PALC 2 (Point Arguello Launch Complex 2), the new facilities incorporate major technical advances over PALC 1, from which all past *MIDAS* and *SAMOS* launches have been made. The $9-million PALC 2 contract also includes some up-dating of the two older pads, however.

## INTERNATIONAL

### French Probe to Test Re-Entry Heating

SEPR, the French company specializing in rocket propulsion, is carrying out the major deevolpment on a four-stage *Bérénice* test vehicle which will be used to test re-entry heating at speeds of Mach 12. Two of the four stages will be fired during climb, two during descent.



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# The Missile/Space Week

## Skybolt Fading Fast

President Kennedy sounded a virtual death-knell Dec. 17 for *Skybolt* as a basic component of the Anglo-American deterrent system.

Predictably, the decision set off a furor from London to Capitol Hill and the White House. (M/R, May 8, 1961, p. 10). The Nassau meeting of Prime Minister Harold Macmillan and President Kennedy doubtless was the key decision-making session before full public announcement of the cancellation.

Meanwhile, the Senate Armed Services Committee threatened financial retaliation against the Pentagon for the *Skybolt* decision. Irritated because they were not briefed on the situation beforehand, Congressmen are doubly upset by what some consider a "double-cross" in connection with the B-70 and *Skybolt* decisions. One senator said: "They told us that the answer to the B-70 was B-52 with *Skybolt*."

Now, with both weapon systems cancelled in essence, although alive in theory, it appears that Congress has been given a fast shuffle. Some members are hoping that final British pressure will pull the missile through, but this seems doubtful.

## Shots of the Week

• *Relay,* NASA's communications satellite experiment, was launched Dec. 13 from Cape Canaveral but failed to maintain full power for its primary tests. Although in a near-perfect orbit, the satellite succeeded only in returning some data on radiation belts, and has little chance of regaining full power to complete its mission (see p. 18).

• *Transit 5-A,* Navy's navigational satellite, was put into polar orbit aboard a *Blue Scout* booster from Pt. Arguello, Calif., Dec. 18. The 140-lb. payload had a failure in its command receiver, preventing transmission of navigational aids to ships and submarines. It is part of a planned four-satellite network giving *Polaris* submarines greater positioning accuracy for launching.

• *Explorer XVI* (S-55) was successfully orbited Dec. 16 aboard a *Scout* rocket from Wallops Island, Va., and all systems are working normally. Data on micrometeoroid particles in space are being received.

• The *X-15* rocket research craft set a new mark for angle-of-attack re-entry with its Dec. 14 flight at Edwards AFB, Calif. With speed exceding Mach 5, Air Force Maj. Robert White brought the craft into the atmosphere at an angle of attack of 25° without the lower stabilizer. Previous high mark for such a maneuver was 18°, and a conventional aircraft would lose control at 15°.

• *Polaris A-2* carrying an *A-3* guidance system was successfully fired from a Cape Canaveral pad Dec. 19 in a test of the smallest inertial guidance system the U.S. has ever built for a military rocket. The 1500-mile flight gave the Mark 2 system a two-minute test, in contrast to the 80-sec. total gained from all six previous tests of the full *A-3* vehicle, which failed on each occasion.

• A *Nike-Zeus* antimissile missile was fired successfully Dec. 19 in the 19th and final test of the *Zeus* at Pt. Mugu, Calif. Tests will continue at White Sands Missile Range, N.M., and Kwajalein Island. The missile carried a simulated nuclear warhead. The Army reported all three stages ignited on schedule.

• Two *Sergeant* ballistic missiles scored bullseyes in field tests by the Army at White Sands Missile Range at undisclosed distances.

• A *Titan II* ICBM was launched on a successful 5000-mile flight from Cape Canaveral Dec. 19 in a full-system test. It was the missile's sixth completely successful test, in addition to three partially successful launchings.

• An *Atlas D* ICBM was launched from Vandenberg AFB Dec. 18 by a SAC crew on a training mission, but blew up shortly after liftoff. There were no injuries or damage, and the cause for failure is not known.

• Four "secret" satellites were fired from West Coast launch pads recently by the Air Force. On Dec. 12, a *Thor-Agena* booster was launched with a classified payload. No results of the launch were released. On Dec. 14, a second *Thor-Agena* was fired, also from Vandenberg AFB. Again, no details were released. On Dec. 17, an *Atlas-Agena* was fired from Pt. Arguello, but failed in flight. It was the first USAF admission that such a classified launching had failed. On Dec.

3, a *Blue Scout* rocket was launched rom Pt. Arguello close on the heels f the successful *Transit* launch. The ehicle was fired at night and no etails were released on its mission r performance.

• Two Canadian *Black Brant* ounding rockets were fired from Vallops Island in a joint Canada-J.S. test Dec. 13. The vehicles car-ied 100-lb. payloads to altitudes of 51 mi., NASA said.

• A *Nike-Cajun* sounding rocket was fired to 68 miles altitude from Andoey, Norway, in a joint Norwegian-Danish-American test of the ionosphere and Northern Lights on Dec. 14.

• Atlantic Missile Range Commander, Maj. Gen. Leighton I. Davis, has announced that no launchings will be conducted during the holiday season of Dec. 22 to Jan. 2, even though supporting ground tests will be carried out.

## Review Delays Ranger

An extensive design review and test program will delay the next launch in the *Ranger* program until the second half of 1963.

The review was ordered by Dr. Homer E. Newell, director of NASA's Office of Space Sciences. It was recommended by a special board set up to study the lunar hard-landing program.

At the same time, a shakeup in the program's management was announced by Jet Propulsion Laboratory, which directs the program under a NASA contract.

JPL said that lunar and planetary spacecraft projects would be merged under a single manager, Robert J. Parks, formerly director of the planetary program. H. M. Schurmeier was selected as the new manager of the *Ranger* project.

C. I. Cummings, formerly director of lunar programs, is temporarily assigned as an assistant on the staff of the laboratory's director, Dr. William Pickering. J. D. Burke, formerly director of the *Ranger* project, was named special assistant to the new *Ranger* project manager.

Newell said that *Ranger VI*—scheduled for launch in the first quarter of 1963—will not be flown. Instead, it will be subjected to exhaustive tests. Changes resulting from the tests will be incorporated into *Rangers VII* to *IX*.

The board's report was submitted to NASA Dec. 4. It declared that certain improvements could be made in the *Ranger* spacecraft design.


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*New concept forming . . .*

# DOD Says AICBM Is Feasible

***Better anti-ICBM system now in planning stages; Hard Point Defense and Urban Defense System weighed***

**by James Trainor**

IN A MAJOR SHIFT in strategic thinking, Dept. of Defense officials now say that ICBM defense is feasible—and worthwhile under certain conditions.

Project *Defender* research and systems studies—combined with the *Nike Zeus* tests in the Pacific—have enabled DOD planners to clarify the ballistic missile defense problem to the extent that a new operational concept is evolving.

Basically, this concept involves two ballistic missile defensive systems—a Hard Point Defense (HPD) system for the protection of ICBM bases and command and control posts and an Urban Defense System. *Nike-Zeus* is an example of the latter.

A more effective AICBM system, presumably based on this operational concept, is now under both conceptual and hardware development, defense officials say. But they refuse to discuss any aspect of the development.

Actual development and deployment of an AICBM does not appear imminent, however. This, in spite of the shift in attitude on operational and technical feasibility, is largely a matter of judgment of timing the development of an optimum system to meet an anticipated threat.

Other non-technical considerations that loom large in the AICBM question are the capability of the Soviet Union—both economically and technically—to build an effective AICBM, and the effect it might have on the Soviets if the U.S. elected to build a ballistic missile defense system.

• **Avoid provocation** — These non-technical considerations, although not clearly dominant, are major factors in the Presidential consideration not to develop and deploy an AICBM.

Basically, leaders in the Administration feel that past U.S. weapon system developments have actually aggravated the arms race and contributed to the instability of the deterrent concept. Past U.S. actions, they claim, have actually forced the Soviet Union into weapons developments they probably would not have undertaken otherwise.

Therefore, several potentially unstabilizing weapons will not be developed and deployed because of the conviction that such action will be met by similar restraint in the Soviet Union. An Urban Defense System almost certainly falls into this category but, depending on the nature of the Soviet missile threat in terms of both warhead yield and guidance accuracy, the Hard Point system may or may not fall into the "not-to-be-developed-and-deployed" class.

(Another class of weapons deliberately not being developed are offensive weapons in space—such as an orbiting bomb. Deputy Secretary of Defense Roswell Gilpatric has openly assured the Soviet Union that the U.S. is not developing, and will not develop, these weapons if the Soviets do not. No such public assurances have been given on AICBM's, but this does not mean that private guarantees have not been made.)

• **But insure** — The Administration is hedging its bets with this approach, however, by developing the technology necessary for such weapons should it be proved that the Soviets are developing them. This is the "insurance" that Gilpatric has cited on numerous occasions —particularly in connection with the development of a manned space interceptor.

As one official puts it in relation to the AICBM, "we would keep a system available so that whenever anyone wants to build one" it would be an engineering problem and not a from-scratch research program.

The viability of this approach, Administration officials feel, is corroborated by analysis of the economic capability of the Soviet Union to build a ballistic missile defense system—even if it could solve the technical problems, a point DOD officials will not concede in spite of Soviet boasts. Economically, the Soviets could build such a system if they were willing to completely disrupt their economic structure for a period of years. Even in a planned economy, administration officials feel, this would be difficult in view of the competing demands of agriculture, consumer goods and undiminished spending on other military hardware.

• **Hard Point defense**—If a decision is ever made to develop a ballistic missile defense system, the most likely candidate is the Hard Point. There are three basic reasons for this: it is less expensive, it is less complex, and it contributes to the policy of a stable deterrent.

From the very nature of the targets it is protecting—hardened missile sites and command and control centers—the HPD has less stringent requirements than those of Urban Defense. First, the area to be protected is small and compact in comparison with an urban center such as New York or Detroit. The hardened sites can already absorb fantastic overpressures, and fallout is not a major problem.

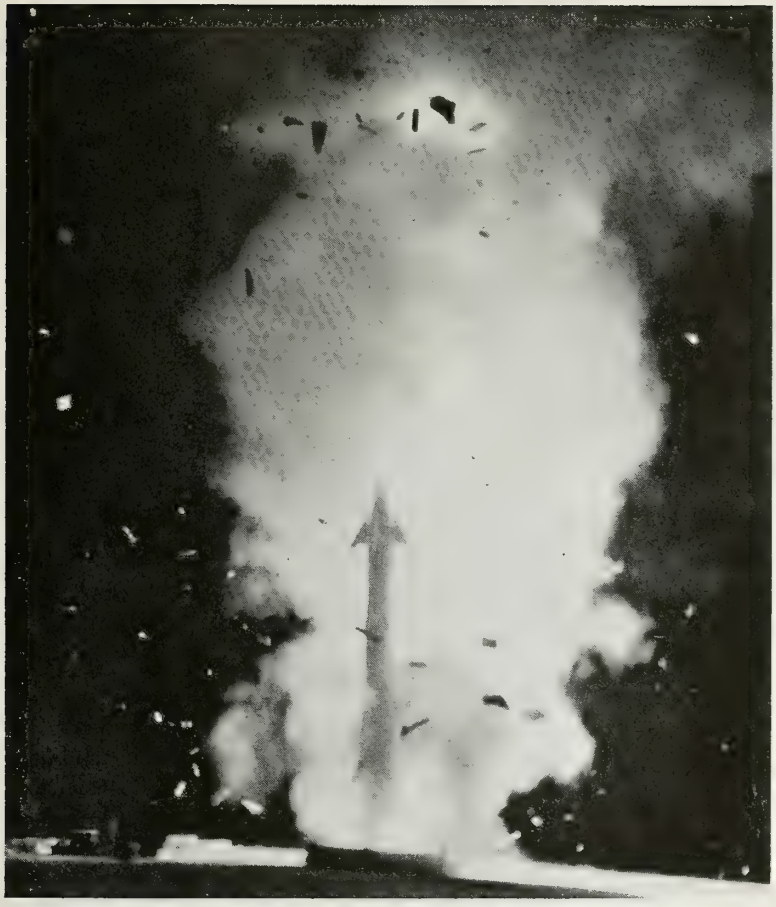
In addition, because of the Hard Point's compactness, attacking missiles must eventually channel into what DOD officials term an "attack corridor or threat tube." Over a hardened target this threat tube is extremely narrow, considerably reducing the acquisition and discrimination problem and consequently reducing the data-processing requirements.

Since the target is already hardened, an additional advantage is the ability to allow for a lower detonation of the defensive warhead. This enables the defense to wait longer before launching the AICBM, thus giving the atmosphere an opportunity to filter out decoy objects.

With these "eased" electronic systems requirements, the HPD can be made smaller and far cheaper on a per-battery basis than an Urban Defense system. Even though the AICBM site must be made at least as hard as the target it is defending, and this contributes to the overall system cost of the HPD where it would not be a consideration in the Urban Defense system, the ratio of HPD to Urban system costs is 3 to 10. Thus, if the often-talked-about cost of development and deployment of the *Nike-Zeus* is $10 billion (as the Army estimates), the cost of an HPD would be in the neighborhood of $3 billion.

Comparisons of this nature are to be avoided, however, since they depend not only on the number of batteries but also on the acceptable attrition rate for hardened targets.

An acceptable attrition rate in the HPD concept is probably the most important consideration, since what is acceptable must be carefully weighed



*ZEUS "blows its top," shedding protective cover in recent Kwajalein firing.*

against the relative cost of attaining this protection. For example, an HPD system might be able to assure protection of 90% of a *Minuteman* wing for a cost $X billion while, by dropping this percentage perhaps just a couple of points, a system can be had for $X-2 or $X-3 billion. A further complication is that even after some force attrition, there must be enough remaining ICBM's to constitute a creditable second strike force.

In the protection of civilian and military command and control posts, however, the AICBM must be protected so that there is minimal attrition. Although command posts are much harder than ballistic missile silos, the defensive problem of providing nearly absolute protection differs so greatly from the missile site problem that they are really quite dissimilar. In fact, defense officials intimate that a third AICBM system—an outgrowth of the HPD—may be required to protect these civil and military command posts.

Development of an HPD system would be but one more element in building a stable second-strike force. With the addition of the AICBM, a first-strike counter-force attack would be made extremely unattractive, Defense officials say. They argue that it would in effect decrease the reliability of the enemy's missile force and require him to increase considerably the number of missiles in the attack force.

The necessity of a HPD system to maintain a stable deterrent in the future would become readily apparent if the guidance accuracy of Soviet ICBM's increased substantially or if very-large-yield warheads, perhaps in the 100 MT category, were employed. Also to be considered are assumptions concerning the Soviet missile inventory and the survivability of the U.S. retaliatory force.

• **Urban Defense system**—In citing the need for two AICBM systems, Defense officials compare their different roles to those of a fighter and a bomber. There is some overlap in the fighter and bomber capabilities, they point out, but one cannot fulfill the mission of the other.

In discussions of urban problems, however, there is notably less enthusiasm and confidence in the effectiveness of an AICBM. As one Defense official puts it, "our concepts are matching the threats better now, but that doesn't say that we have arrived at a solution, just that we are getting closer."

What must be avoided, they assert, is the development of an extremely expensive system which, with minimum effort and resources, can be counteracted by the enemy. For considerably less money, penetration aids can be developed to circumvent an Urban AICBM system.

DOD officials admit, however, that the AICBM problem has been getting more serious consideration in the Defense Department recently than ever before. One official attributes the change in attitude to an accumulation of test data from the Pacific *Zeus* tests, design improvement in the *Nike-Zeus* Urban Defense system and better definition of the possible threat.

Although *Nike-Zeus* is not a research vehicle, there is universal agreement that, even if *Zeus* were approved for production and deployment, a considerable development program would have to be undertaken. This is primarily because *Zeus* is a constantly changing, constantly evolving system taking advantage of all that is learned about ballistic missile defense. As a weapons system, however, its design would have to be fixed upon and a 3-4 year development program undertaken.

• **Sprint: pure Army**—One of the newest developments in the *Zeus* system is the *Sprint* missile (Sprint stands for just that) which will not replace the present *Zeus* missile but rather supplement it. In other words, the *Sprint* missile will be part of the missile mix in a *Zeus* battery.

Defense officials are quick to point out, however, that *Sprint* is purely an Army development which the Army feels will improve the effectiveness of the overall *Zeus* system. It is not to be confused, they say, with various open-end programs in ARPA designed to provide the technology for extremely high-performance missiles.

*Sprint* is a high-acceleration missile which, in combination with the *Zeus* missile, would allow each battery to handle more targets by intercepting reentry bodies closer to the ground. In addition, the missile could be used to destroy warheads after the atmosphere has stripped them of accompanying penetration aids.

Study contracts have been issued by Bell Telephone Laboratories — prime contractor for the project—to Douglas Missile and Space Systems Division, Martin-Orlando, and North American Aviation's Columbus Div. Estimated cost of the *Sprint* development is $30 million. The studies are due for completion Feb. 1. ⁂

# Mariner Triggers Intensive Activity

***Probe's spectacular success lays foundation for further exploration of Venus, Mars in 1964; early data expected***

**by Hal Taylor**

THE SUCCESS of *Mariner II*, America's greatest space achievement to date, means the certain go-ahead on a far more advanced interplanetary exploration program in 1964.

Two fly-by missions of both Venus and Mars will be attempted. A total of six *Mariner R* spacecraft will be built and two launch pads at Cape Canaveral will be utilized.

The flights will be based on *Mariner II*'s performance and the excellent scientific data it telemetered back to Earth for 42 min. before its closest approach (21,594 miles) to Venus (10 sec. before 3 p.m. EST Dec. 14).

• **Early results expected**—NASA officials declared instruments and telemetry worked so well that some indication of Venus temperatures can be expected possibly by Dec. 26, rather than in the six months some experts had anticipated.

The 447-lb. spacecraft was launched from Cape Canaveral Aug. 27. Three days after launch, four experiments to measure magnetic fields, cosmic dust, charged particles and solar plasma were turned on. Since that time, the four instruments have sent back more than five million data points of information.

Major findings include discovery of a constant solar wind in space and the determination that there are 10,000 times more cosmic particles close to Earth than in deep space.

*Mariner* kept its date with destiny at 1:55 p.m. EST Dec. 14, when its two radiometers—infrared and microwave—began to scan the Venus surface and report back its finding on the planet's temperature and atmosphere. The scanning period ended at 2:37 p.m. EST. When it was finished the $50-million interplanetary program had sent back to Earth more information about Venus than has been obtained since the beginning of civilization.

NASA officials hailed it as America's greatest scientific achievement and a major victory over Russia in the space race. It also set a long-distance communications record of 36 million miles.

Data from the radiometers is expected to determine whether any form of life is possible on Venus. Experiments on Earth have indicated that the highest temperature in the planet's atmosphere is 600° F. If this is confirmed by *Mariner*, no life is possible.

The spacecraft is now in orbit around the Sun with a period of 345.9 days.

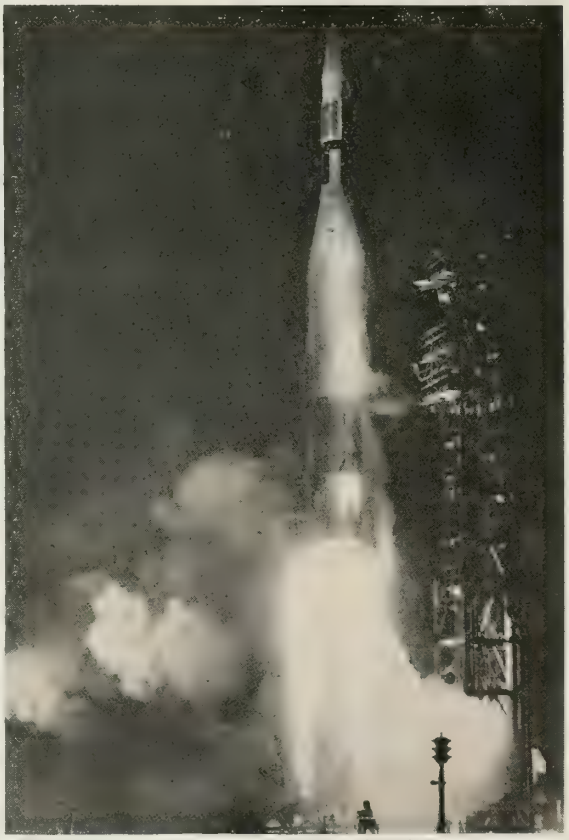
The spacecraft is still sending reports from its four scientific experiments. How long this will continue depends on how well the Earth sensor retains its lock on this planet, and on temperatures inside the spacecraft.

• **Temperatures a problem** — High temperatures were a problem throughout the flight and for a time threatened its success. Temperature of the battery recently registered 135° F. Earlier, JPL scientists had estimated that 130° F was the absolute maximum temperature that it could survive. Other high temperatures registered by spacecraft components include Earth sensor, 165° F, and solar panel, 255° F.

The temperature problem will have to be solved before NASA can begin to firm up its plans for the 1964 interplanetary missions.

NASA now plans to launch the two Venus fly-bys early in 1964. Two *Atlas Agena* launch pads at Cape Canaveral will be used so the two launches can be made in the short two-week "launch window." Two Mars fly-bys will be attempted late in the same year using the same launch pads. Of the six *Mariner R* spacecraft required, four will be flight models and two will be test vehicles.

Experiments for the two Venus flights are currently being formulated. They will be closely similar to the *Mariner II* instruments, but their ranges will probably be refined so that they will provide more information. For the Mars flights, it is likely that an attempt will be made to take TV pictures of the



*LAUNCH OF Mariner II Aug. 27 aboard Atlas-Agena.*

planet's mystery-shrouded surface.

In preparation for the 1964 flights, NASA will shortly begin an extensive life test program using a *Mariner R* spacecraft left from the 1962 program.

• **Future temperature controls**—JPL engineers are already considering heat-control measures they will use on the two *Mariner* vehicles to be launched toward Venus. No final decisions will be reached until all the data from the flight of *Mariner II* have been exhaustively analyzed. To a large extent it will be possible to avoid the excessive temperatures of *Mariner II* by altering the reflective paint patterns on the various components.

Thermal shields will probably be installed to shade some components from the direct rays of the sun. Thermostatically controlled louvres on sides away from the sun are likely to be used more widely than on *Mariner II*.

By opening and closing in response to internal temperature changes, these increase and decrease the rate at which heat is radiated into cold space. JPL spacecraft designers are not enthusiastic about either of these solutions, regarding them as "brute force engineering." Their additional weight would be subtracted from the payload.

*Mariner II's* spectacular success represents a major triumph over a long series of obstacles both before and after its launch.

With only 10 months remaining before the 54-day Venus launch period which occurs every 19 months, JPL scientists began a crash program to redesign the entire spacecraft.

The result: All experiments originally included in the spacecraft mission were retained, although not as elaborately as first conceived.

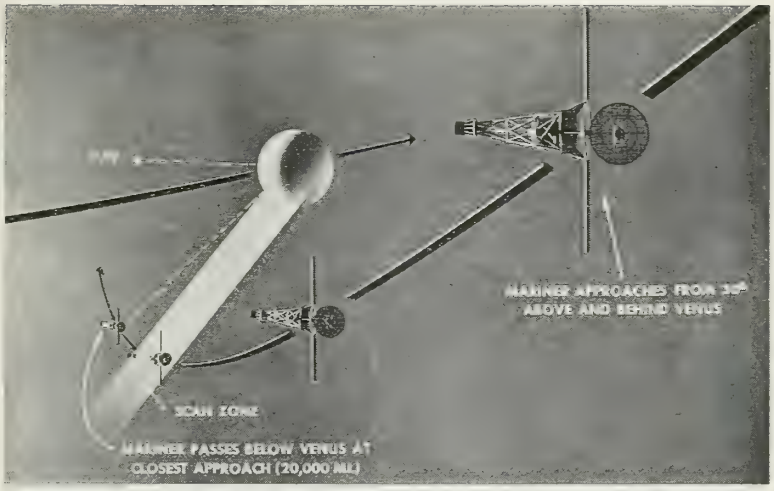
Spacecraft systems worked smoothly for the first week, but on Sept. 3 tracking data indicated the spacecraft would miss Venus by 223,000 miles.

• **Critical maneuver** — The mid-course guidance correction was attempted one day later. To achieve it, the spacecraft had to roll through nine degrees, turn over through about 140 degrees and turn on its rocket engine in order to boost its speed by 90 ft. per second. The whole maneuver took four hours.

It was only partially successful. NASA announced that the spacecraft would miss Venus by some 20,000 miles compared to the 9000-mile planned fly-by.

On Sept. 8, a disturbance momentarily knocked the spacecraft out of its attitude control. It is still not known whether it was caused by a meteoroid or an electrical malfunction. It lasted only seconds before the spacecraft righted itself.

Another problem arose on Sept. 29.




*PATH OF Mariner II during Dec. 14 Venus fly-by depicted in artist's conception.*

Roll control of the spacecraft was lost for a few minutes because of a malfunction in the Earth sensor.

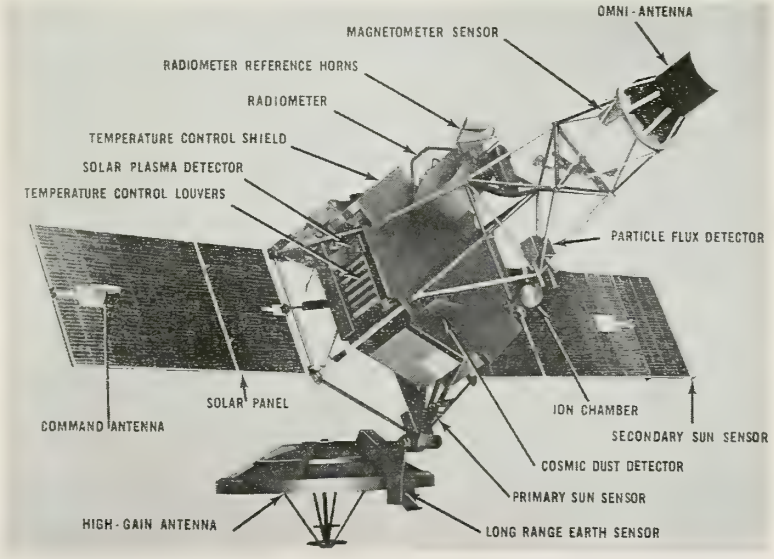
On Oct. 31, the spacecraft was again beset by a technical ill that lasted throughout the remainder of its mission. An electrical short developed in one of the solar panels. For a week all scientific experiments were turned off while the short was checked. The short corrected itself and the experiments were turned back on. Seven days later the short was again present, and it persisted through the rest of the flight. Officials said that sufficient redundancy in the power system enabled the spacecraft to continue to operate.

A major problem—and one which threatened the success of the mission right up to the moment of the Venus fly-by—was the unexpected overheating of on-board spacecraft components as its long flight took it closer to the Sun.

• **Closing in**—At 8:35 a.m. EST Dec. 14, however, the Goldstone Tracking Station in the California desert flashed a radio command to *Mariner II* across 36 million miles of space as the spacecraft neared Venus.

Six and a half minutes later, Goldstone received verification that the spacecraft had received and acted on the command and that the two radiometers on board had started to scan. The spacecraft also went into the Venus encounter mode—in which it shifted from sending mixed science and engineering telemetry to transmission of science telemetry only.

At 1:55 p.m. EST, the two radiometers—infrared and microwave—began to scan the cloud-covered planet. This lasted 42 minutes—until 2:37 p.m. ⁂




*SCALE MODEL of Venus viewer shows some of scientific equipment aboard spacecraft.*

*Failure delays program . . .*

# Relay Power Rejuvenation Unlikely

***Low-altitude ComSat is victim of low battery voltage; cause still under study by Goddard scientists***

A POWER-SYSTEM malfunction has probably killed NASA plans to conduct communication experiments with its low altitude *Relay* satellite.

The unsuccessful flight is also expected to delay the second launch in the series until the second quarter of 1963 at the earliest.

The active ComSat was launched with an improved *Delta* booster Dec. 13. The low battery voltage was discovered when the first test of the satellite was attempted in its fifth orbit.

Scientists at the Goddard Space Flight Center were still studying telemetry data last week in an attempt to detail the cause of the low power supply.

• **Failure cause uncertain** — They have ruled out failure in the battery or solar cells.

A defect in the system's circuitry was blamed, but no decision has been made as to the specific cause of the problem. Spurious command signals or a faulty regulator was considered possible.

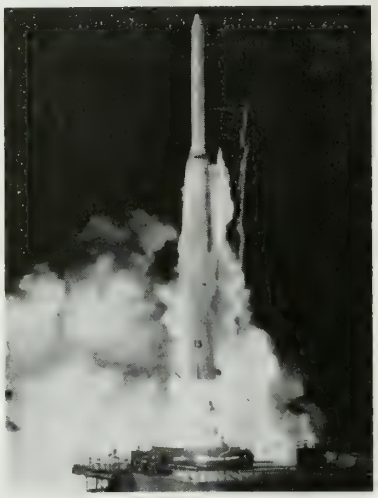
Goddard scientists were still hopeful that the power system would snap back, but this became more and more remote as the time during which its batteries were not recharged lengthened.

A backup spacecraft is available and could be launched as early as six weeks after *Relay I*. Some time will probably be lost in an effort to insure *Relay I* malfunction will not be repeated. Further delay will also be forced by the scheduled launch of the high altitude *Syncom* communications satellite in mid-January. If it is successful, NASA will probably put off the *Relay* flight until experiments and tests on *Syncom* are completed.

Relay was expected to add to the space-communications technology developed by the successful launch of AT&T's *Telstar* satellite. While both are low-altitude satellites, *Relay* is far heavier and has more communication channels.

*Relay I* marked the first flight of the *Delta DSV-3B*, which is destined to become the workhorse of the Space Age (M&R, Sept. 24, p. 28). It was the 14th straight *Delta* success.

The new vehicle combined the more powerful first-stage *Thor* booster, which



*DELTA LAUNCH vehicle lifts Relay.*

delivered 165,000 pounds of thrust, and the improved second stage which provided an additional 45 sec. of burn time.

All three stages performed normally and the *Relay* orbit of 819-4612 miles closely approximated the planned orbit of 700-4500 miles. The orbital time of 3 hrs., 5.09 min. was near the planned 3 hrs., 4 minutes.

A considerable portion of the spacecraft's 172 lbs. is given to the power supply system. In the 67.02-lb. system are eight solar panels with 8215 P-on-N silicon cells, three battery systems connected in parallel, three charge controllers, voltage and discharge limiters, one low-power and two high-power regulators, and a timer to turn off the spacecraft after one year.

Each of the P-on-N silicon solar cells is covered with 60 mils of fused silica for radiation protection. The batteries include 60 nickel-cadmium cells.

A 4 by 5-in. patch of 30 solar cells on the side of one panel is to provide a comparison for checking radiation damage to cells.

Six radiation detectors also point out through openings in solar panels covering all sides of the spacecraft to provide additional checks on radiation intensities in space.

Internal temperature of the spacecraft is controlled by a set of vanes that are to permit excess heat to escape. The vanes are activated by a hydraulic system that depends on a gas-filled bellows to reflect temperature variations.

A speed of 150 rpm was scheduled to control spacecraft attitude in flight, but a magnetic torquing coil was carried to permit trimming the attitude through reaction with the Earth's magnetic field. A sun-aspect indicator and horizon scanners are to establish the attitude for a telemetry report to the ground.

The 10-watt traveling wave tubes carried on *Relay* are designed to produce four times as much power as *Telstar* and to expand *Telstar's* U.S.-Europe television link to include South America.

The network of stations is to include Andover, Me.; Nutley, N.J.; and Mojave, Calif.; Rio de Janeiro, Brazil; Goonhilly, England; Pleumeur Bodou, France; Raisting, Germany, and Fucino, Italy. Japan is to be added.

• **Transmission plans**—Initial transmission plans called for wideband between the U.S. and Europe and narrowband between the U.S. and South America. There will be no television transmission to Brazil until Brazil has TV-reception capability.

Spokesmen for RCA, which developed and manufactured *Relay*, said the importance of providing relatively high power was the key factor governing construction of the spacecraft.

They said this established the size of the power source, and the spacecraft was designed to provide as large an external surface as possible that could be contained in the *Delta*-nose fairing for the large array of solar cells.

RCA and Goddard spokesmen said a second *Relay* spacecraft is being tested preparatory to launch in the second quarter of 1963. A third *Relay*, originally intended as a backup for *Relay II*, is now being fabricated in an RCA plant.

Principal changes planned in the second vehicle now call for a change from the P-on-N to the N-on-P type of solar cells. ⁘

***Awards may come in April . . .***

# Solid Program Strictly Demonstration

***No prime contractor envisioned; final motor may be over 300 in.; 156-in. units likely to be used for sub-scale tests; work to spread***

INDUSTRY WINNERS in the upcoming large-solid-booster demonstration competition may face a facility squeeze—no funding is slated for 260-in. installations initially, yet they are necessary to meet the proposed fabrication and firing of the big motors.

The proposed systems package plan is now going through final review stages, and if everything goes perfectly, contracts should start coming out about April, 1963. Details of the program are not available but it is known that:

—There will be no prime contractor. Instead, there will be one or more "main line" efforts directed toward the construction and firing of large solid motors in the 260-in. class. The 260-in. designation is not fixed; the final motor might be larger—in the 300-325-in. area. The potential exists, say NASA/AF officials.

—Maximum use will be made of existing propellant facilities, skills and hardware.

—The demonstration program will involve sub-scale firings and this is taken to mean sub-length 156-in. units. AF/NASA officials say 120-in. components such as nozzles are too small for meaningful data directed toward 260-in. units, while the 156-in. size meets the requirement. But the 120-in. program is expected to provide data in many areas.

—Waterside facilities are a necessity, particularly in the second phase of the program—the 260-in. fabrication.

—Design flexibility will be called out, as in tail-off times, for instance.

• **Low-level effort** — Both NASA and Air Force officials emphasize the demonstration nature of the proposed program—there is no development involved at this time. The waterside site factor is not going to be spelled out in the proposal requests nor will there be any mention of new facilities.

There is an extreme reluctance on the part of the Air Force to appear to be advancing a new breed of boosters, even to the avoidance of using the term *Nova*. The big solid program is aimed at establishing the feasibility of the huge boosters while taking advantage of the current *Titan III* solids effort. There seems to be some chance of more than one or two 260-in. firings, but this depends on progress during the first 18 months of the program.

The large solids plan is an Air Force program arising from the recent DOD/NASA agreement. It will be managed by USAF Systems Command's Space Systems Div. NASA requirements involved are general and call for units in the 6-to-7-million-lb. thrust range. The final vehicle currently envisioned will cluster four of the huge solids.

First phase of the work will cover sub-scale developments including the building of short, 156-in. segmented units. These motors will be amenable to test firings on any test stands capable of handling the 120-in. class.

Nozzle, thrust vector control and other inert components development will parallel sub-scale work. While the entire program will be geared to state-of-the-art technology, innovations with reasonable assurance of success will be funded on a limited basis.

Most subcontracts probably will be issued by the main line contractors, but certain items might be funded separately by the Air Force as the program moves along. This would be done in much the same manner as with certain components in the 100-in. motors fired over the past 18 months.

NASA will be intimately involved throughout the demonstration program. There is some talk of setting up review committees designed to keep the space agency abreast of developments and permit changes as the general areas of technology advance.

• **Spreading the work** — Bits and pieces of the large solid demonstration package probably will be spread throughout the solid-propellant industry, but the exact nature of the proposal request is not known. Several firms have made moves in anticipation of the RFP's. Aerojet-General's breaking ground in Florida this month is the most recent.

The General Tire subsidiary announced its plans in November to build a multimillion-dollar solid propellant plant on a 75,000-acre waterside site south of Miami. Scheduled for operation in the spring of 1964, the plant will initially have the capacity to satisfy what Aerojet terms "near future" requirements but with a built-in expansion potential.

The same firm recently held a meeting with representatives of shipbuilding and other fabricators of large metal structures. The two-day affair was to acquaint these firms with the stringent requirements anticipated in handling motor case and nozzle work for large solids.

The firms involved were Bethlehem Steel and Shipbuilding, Kaiser Aircraft and Electronics, Chance Vought, Curtiss-Wright, Todd Shipyards, Electric Boat Div. of General Dynamics, Martin Co., Ingalls Shipbuilding, New York Shipbuilding, Willamette Iron and Steel, Westinghouse Astronuclear, Sun Shipbuilding and Drydock, Douglas Aircraft and the Prosperity Co.

The representatives attended sessions on X-ray, radiographic and hydrotest procedures used in the normal propellant production business of Aerojet. Other lectures covered the special, high-strength metals involved in booster cases and the manufacturing techniques.

Some of the attendees were already well versed in solid rocket case technology. Curtiss-Wright currently builds both *Minuteman* and *Pershing* vessels; Chance Vought handles the *Scout*.

Aerojet spokesmen say some of these firms will be invited to join in bidding for the large booster program.

Thiokol Chemical has also moved in this direction with its Georgia tract and the creation of its Alpha Group. Both firms have been pushing for a large solid program for years.

Hercules Powder, Lockheed Propulsion and the Solid Rocket Division of North American's Rocketdyne Div. are also expected to bid in some, if not all, areas. United Technology Center, already deeply involved in the *Titan III* 120-in. strap-on booster program, is known to be especially interested in the segmented 156-in. aspects of the program but has not yet shown any inclination to limit itself to tihs phase. ⁂

# AF Ponders Big-Solid AGE Problems

***Study contract to American Machine & Foundry aimed at defining current capabilities and future needs for handling and launching***

**by Michael Getler**

FINAL CONCEPTS for the Integrated Transfer and Launch (ITL) of *Titan III* are now being worked out by the Space Systems Division of the Air Force Systems Command, the Martin Co., United Technology Center, Aerospace Corp., and the Ralph M. Parsons Co. (architecture and engineering contractors).

Contracts for aerospace ground equipment (AGE) are expected to come from the prime contractors early next year. There are indications that the Martin Co. may issue its first requests for proposals on the ground transporter next month.

Meanwhile, a document which could became a veritable AGE "bible" for upcoming space programs requiring large solid-fuel boosters is being put together by American Machine & Foundry's Government Products Group in Stamford, Conn.

Working under an $81,000 contract from the Air Force Flight Test Center at Edwards AFB, Calif., AMF engineers are preparing a comprehensive rundown on the entire scope of support equipment required for solid boosters ranging in motor diameter from 65 to 300 in., and including both segmented and unitized design approaches.

AMF says the sheer size and weight of these motors (see table), especially those in the 260-in. category and beyond, will tax the capacity of facility planners and create a new surge of R&D by AGE suppliers.

United Technology Center is a subcontractor to AMF on the study, supplying details on solid-fuel propellants which affect development of equipment to handle the boosters.

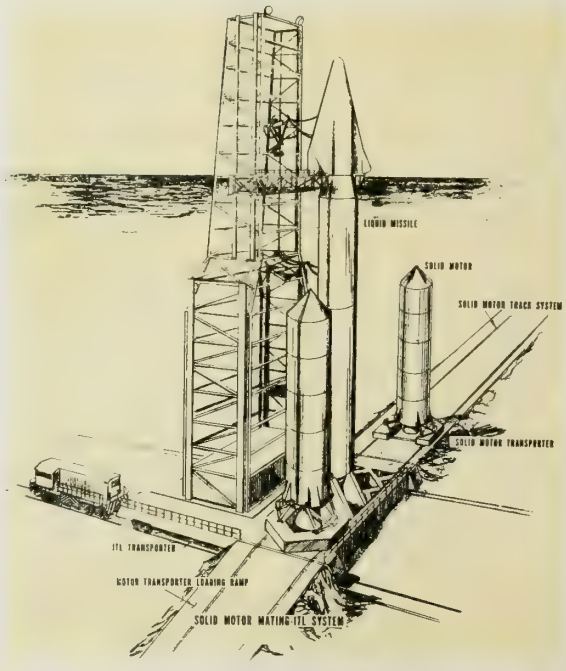
Project manager at Edwards is Lee B. Thompson; at AMF, Bernard London, manager of the firm's ground systems department.

• **Current guide**—Basically, the AF-AMF study will provide in one place an up-to-date statement as to which future space programs are likely to require solid boosters, what the current weights and dimensions of these vehicles are, what type of equipment is needed to handle them, how much of this is available, and how much will have to be developed.

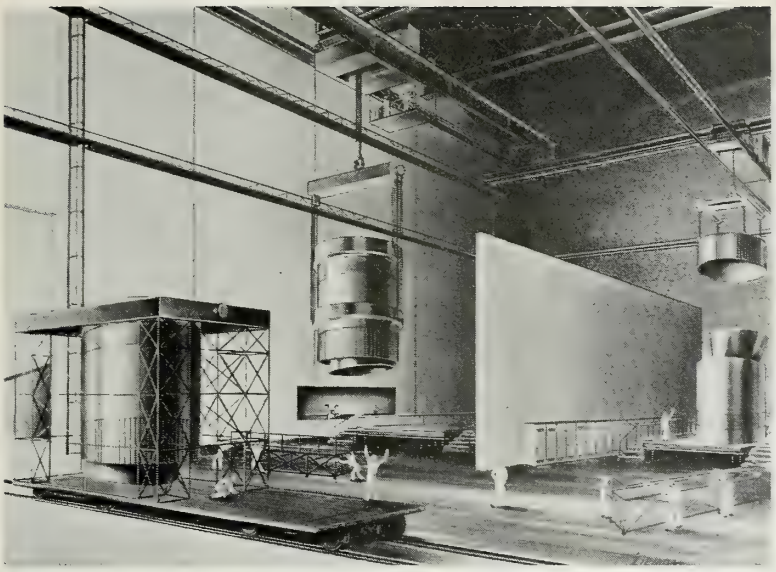
Since the AGE required for these programs is intimately tied to site layout, the study will reflect the latest AF and NASA thinking on facilities for various projects. AMF, which has an extensive background in site development (*Atlas* and *Titan I* silo-launch systems, and Projects *Hydra* and *Phoenix*) is also expected to contribute.

Though the study, which began in May, is being made under Edwards' sponsorship, the final report—due in April—is likely to be widely disseminated throughout all AF weapons and space systems planning offices, NASA, solid-fuel motor prime contractors, and GSE firms servicing the industry.

In its final form, the report should contain—in addition to the handling requirements and program data—the most complete listing of ground support firms, what they have, what their




*MATING of the two solid-fuel UTC motors with liquid-fuel Titan II core is shown in this AMF artist's drawing. Entire unit is then moved to the pad.*



*AFT CLOSURES and nozzles are mated as first step in assembling giant Titan III. Aft closure-nozzle assembly (left) in UTC artist's drawing is ready to be moved to nearby Solid Motor Assembly Building, where it will be joined with four other segments to complete a 120-in. dia. booster. Two such boosters will give 2-million lbs. of thrust.*

equipment capabilities are, what is on the drawing boards, and an evaluation of these new designs. For the industry, the report should provide a guide to the projected programs and a clue as to where R&D money can best be spent.

How thoroughly the final report will treat the overall AGE situation depends to a great extent upon information supplied by the equipment producers. In May, at the outset of the study, AMF contacted about 400 firms and requested, among other things, details on new equipment and techniques either planned or under development. Early response was good, but some firms apparently were reluctant to produce proprietary information in the interests of a complete AF study.

This was said to be mostly among larger firms with substantial information-gathering services of their own. However, as the study gained momentum, the problem faded. AMF now reports that virtually 100% response has been achieved.

• **New advances**—In some cases, AMF reports, information received from industry has already uncovered what appear to be solid advancements in very-heavy lifting (600 tons) equipment and radiological propellant-inspection techniques.

The AMF study now centers upon the AF's 624A (*Titan III*), NASA's *Advanced Saturn,* and a solid-fuel version of *Nova.* The report, which is said to be continually updated, was also amended to list the AGE requirements for a possible solid-fuel version of the *Saturn C-1* first stage.

Of these programs, the first one likely to go into actual hardware requirements will be the AF's *624A* project, involving the mating of two 120-in. solid fuel booster engines with the liquid-fuel *Titan II* booster.

Pending final ITL concepts, AMF has included some of its own ideas on what a *Titan III* launch complex might look like in the EAFB-sponsored study. These concepts, with some modifications in the R&D launching phase, are reported to be fairly close to the expected final ground system design. Project directors say earlier AMF studies of ground systems for Project *Phoenix* laid much of the base upon which the *Titan III* complex is evolving.

• **AMF design**—The firm's original proposal on the heavy solids study contract envisioned two distinct ground systems for *Titan III*—one for relatively low launch rates up to 10 per year during the R&D phase, and another for the higher rates between 10 and 100 annually which could be expected during operational usage. Overall site design also includes adapting R&D equipment and facilities wherever possible.

The low launch rate system, according to AMF, involves erecting the *Titan III* solid motors on individual transporters within a universal mobile service tower on the launch pad. After assembly, the solid motors will be transferred to storage facilities, and the liquid stage assembled on the launch pad with the aid of the service tower. When the liquid staging assembly is completed, the solid motors will be returned to the pad and attached to the liquid asssemblies. The mobile service tower will then retract and the complete vehicle will be ready for launching.

For higher launch rates, liquid stages will first be brought to an integration building to be checked out, assembled, and mated to a transporter platform. This platform includes the umbilical tower; all connections between the liquid stages and the umbilical tower are accomplished in the integration building. Solid components will first be brought to a separate facility to be inspected and stored until ready for assembly. After solid segments are assembled into complete motors at this facility, the parallel mounting of liquid stages and solid propellant motors will be accomplished on transporters in an intermediate station. Here preliminary checkout of various solid motor functions—including thrust vector control system, ignition system, and destruct system—will occur.

Finally, the transporter will move to an essentially bare launch area with the platform serving as the launch pedestal. AMF says only simple, direct connections between the bottom of the umbilical tower and the pad facilities are required for a final vehicle confidence check and countdown. Storable liquid propellants will be brought to the launch pad by tank cars via the transporter track network.

AMF engineers point out that the flexibility of the transporter devices in the system could allow mating of solid and liquid portions at more than one location (at an intermediate station or right at the launch area)—depending upon which was more favorable with respect to time and complexity. They also note that gantry equipment developed for R&D mating of systems could also be used to speed solid-motor assembly during operational launchings. ⌘

## TENTATIVE GROUPINGS BASED ON MOTOR DIAMETER RANGE

| DIAMETER RANGE INCHES | SEGMENTED APPROACH | | UNITIZED APPROACH | |
|---|---|---|---|---|
| | MAX. HEIGHT (PER SEGMENT) INCHES | MAX. WEIGHT (PER SEGMENT) POUNDS | MAX. HEIGHT (PER MOTOR) FEET | MAX. WEIGHT (PER MOTOR) POUNDS |
| 65 - 130 | 160 | 120,000 | 100 | 1,000,000 |
| 130 - 180 | 300 | 400,000 | 120 | 2,000,000 |
| 180 - 300 | 360 | 750,000 | 150 | 5,000,000 |
| 300 & greater | 480 | 2,000,000 | 150 | 10,000,000 |



**Who'd have thought a 14-track 300 KC recorder could fit into a case this small?** **AMPEX**

Here is the portable recorder you've been waiting for: the new Ampex FR-1300. It offers all the performance, all the reliability of much larger rack-mounted instrumentation recorders. Yet it fits into a portable case only 24 inches tall. In fact, it's so compact and lightweight that you'll find yourself treating it like any standard piece of laboratory or test equipment; moving it from job to job or lab to lab. And just look at all you get: 14 tracks, Direct and FM recording, six electrically selected speeds,



recording capability from 300 cps to 300 KC at 60 ips—and all solid-state electronics throughout, all packaged in one portable case. The FR-1300 also features a built-in capstan servo system to guarantee accurate tape speeds, without the need for an accessory motor drive amplifier. For more details write the only company providing recorders, tape and memory devices for every application: Ampex Corporation, 934 Charter Street, Redwood City, California. Worldwide sales, service.

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# Technical Countdown

## ADVANCED MATERIALS

### New Ta-W-Hf Alloy By Westinghouse

An alloy with high strength capability from near absolute zero to white heat and room-temperature workability will soon be in pilot plant production at Westinghouse Electric. Designated T-111, the alloy consists of tantalum, tungsten and hafnium, and has an operating range between 2000° and 3500°F. Ductility extends down to −452°F. Not a lightweight metal, the alloy can be welded or fabricated with "relative ease," say Westinghouse researchers, and even cold-rolled at room temperature. The development is a result of four years of Navy-sponsored research. Present plans call for availability in most mill shapes from the firm's Blairsville, Pa., plant.

### Nitro Polymer Moves Into Continuous Mix

Aerojet-General is running the high-energy, nitro-polymer, *Polaris A-3* propellant through its continuous-mix production facility, The upgraded propellant aids in pushing the *Polaris* to its 2400-mile ultimate range. The continuous-mix plant has been in operation for five years, producing polyurethane propellant for the *A-1* and *A-2* missiles. Its high safety potential derives from the fact that only 20 lbs. of propellant are under preparation at any one time. Batch processes usually handle up to 2200 lbs. in any one instance. The firm also crossed the 100-million-lb. mark in propellant production recently.

### Wyman-Gordon Forging Dyna-Soar Members

The primary load-carrying structural members of the Air Force's *X-20* (*Dyna-Soar*) re-entry glide vehicle are being forged in Wyman-Gordon's secrecy-shrouded North Grafton, Mass., plant. The material used is René 41, a high-strength superalloy forming the *X-20's* "cage" structure. Since the *Dyna-Soar* depends on radiation to remove fuselage heat, structural members must meet exact metallurgical and forming specifications. Wyman-Gordon's USAF plant houses a 50,000-ton press, the largest in the world. The plant also forms parts for the AEC, hence the extreme security precautions.

### Teflon Hose Stress-Cracking Avoided

A new process for producing thin-wall Teflon extrusions for the innercore of wire-braided hose vastly increases the material's resistance to stress-cracking. Developed by Titeflex after a three-year research effort, "ZE" (Zero-Effusion) innercore produced through the proprietary process has undergone intensive testing. While current hoses easily meet aircraft specifications, the trend toward higher system operating temperatures and pressures forced elimination of stress-cracking before it became an operational problem.

## PROPULSION

### UTC Fires 12-Segment Solid Rocket

United Technology Center fired a 12-segment solid rocket in a test of an advanced ignition system for large boosters. The 30-ft. rocket developed 82,000 lbs. thrust for about four seconds. Each of the segments produced some 6800 lbs. thrust. Data obtained from the Air Force-sponsored test indicates feasibility of an igniter firing down the 12-segment core for ignition of very large segmented boosters generating millions of pounds of thrust.

### Searcher Rocket Tested at PMR

A shipboard-launched, rocket-boosted system designed to aid Navy units in locating missile nose cones, aircraft or personnel at sea is being tested at Pacific Missile Range. Designated *"Searcher,"* the vehicle with payload is 107 in. long and weighs less than 100 lbs. Signals from transmitters aboard the hunted objects are received by *Searcher* antennas. Developed by Space-General Corp., the system is expected to locate objects in the water within a 125,000-sq.-mi. area without using aircraft.

## ELECTRONICS

### Super-Speed Data Transmissions Demonstrated

IBM last week demonstrated an experimental high-speed data-transmission system that offers a multi-magnitude improvement over existing systems. With one test system, scientists transmitted at a rate of 33 million words per minute (20 million bits/sec.) over a TV link. With another, they achieved 8000 bits/sec. over a single-hop, carrier-quality telephone link. Transmissions are self adaptive—a test impulse is transmitted first to check the received signal, and the system then adjusts signal level for an optimum output.

### Infinitesimal Mariner Signals Received

NASA's 280-ton, 85-ft. paraboloidal reflector antenna at Goldstone, California, received signals from *Mariner II* (as it approached its Venus rendezvous) having a calculated power of only $10^{-18}$ watt. The steerable dish, says antenna builder Blaw-Knox, is capable of a tracking accuracy of 0.01° of arc.

### GUSTO to Go in '63

A top Air Force officer has expressed hope that a satellite navigation system using atomic clocks may be lofted into orbit in a piggyback payload for testing during 1963. AF Project GUSTO (Guidance Using Stable Tuning Oscillations) employs an atomic clock approach to the guidance problem; such clocks are reported to be accurate to 1 part in $10^{12}$.

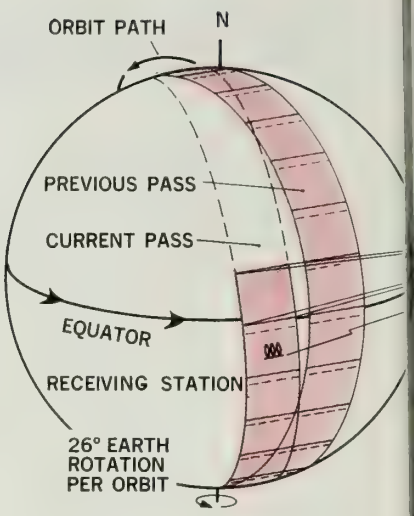
### X-ray Plate to Give 10,000 Pictures

An electronic X-ray plate has been invented by Thorn Electrical Industries, St. Martin's Lane, London, W. C. 2. It consists of a steel plate with a coating that is sensitive to both light and invisible radiation. It produces a picture which is immediately visible without developing. The picture glows in shades of light and dark down to pitch black, and when the device is switched off it is instantly ready to take another picture. Developers estimate that a single plate can take at least 10,000 successive pictures.

# Nimbus To Test 'Poor Man's Weather Station'

***Automatic transmission system could deliver local cloud-cover pictures to every spot on Earth***

**by William Beller**




A SATELLITE weather station transmitting pictures of local noontime cloud-cover to every spot on Earth is expected to come out of an experiment designed for the *Nimbus* meteorological satellites.

If the experiment turns into an operational system, it will probably bring more daily benefits to more people than any other project in the world's space program.

Recent successful ground tests of the system, called the Automatic Picture Transmission Subsystem (APT), show it is ready to be tried out on an orbiting vehicle (M/R, Dec. 10, p. 13). Although a *Tiros* satellite was chosen for the preliminary flight-test job, the better test of APT will come next fall when it goes aboard a *Nimbus* on its first scheduled launch.

When APT is an operational system, probably sometime in 1964, it will take photographs of cloud patterns beneath it—during every three minutes of its near-polar orbit—and send them to weather stations within a 1700-mi. range. The receiving equipment needed is expected to cost only about $30,000—a requirement set up to allow weather stations throughout the world to afford it.

The ground equipment will consist merely of a broadly directional helical antenna and a receiver feeding a facsimile machine.

NASA's Goddard Space Flight Center, Greenbelt, Md., is managing APT. Radio Corporation of America is contractor for flight hardware, and Fairchild Stratos is contractor for experimental ground equipment.

• **Always 12 o'clock**—*Nimbus* will be sent on an orbit inclined 80° to the equator. Since additionally it will be Earth-stabilized—the same satellite face always pointing toward the center of the Earth—it will "see" every spot on Earth every day: the Earth's rotation will introduce a survey of longitudes and the satellite's orbital motion will cover latitudes.

The best conditions for observing Earth are obtained by launching the satellite near noon or midnight; this launch yields an orbital plane containing the Earth-Sun line. Traveling such an orbit, *Nimbus* will view Earth at near local noon on the sunlit side and near midnight on the dark side.

*Nimbus* will be fired from the Pacific Missile Range by a *Thor Agena B*. The satellite is expected to attain a 500-mi. circular orbit and spend about 68 minutes in sunlight and 35 minutes in the Earth's shadow.

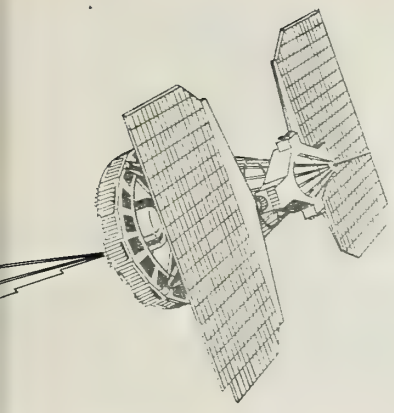
• **Easy system to use**—Every day,



*GROUND-BASED antenna for receiving cloud pictures.*



*CONSOLE and facsimile machine for APT weather stations.*



ground stations in moderate latitudes may receive up to seven pictures of local cloud cover from APT, according to Dr. William K. Widger, Jr., NASA's chief of operational meteorological satellite programs. Each picture will show an area about 1000 mi. by 1000 mi., including about a 300-mi. overlap between pictures.

At the equator, owing to the relatively large lateral ground trace between each orbit of the satellite, the stations will be able to pick up only about three pictures—all around local noontime.

At mid-latitudes, on the other hand, the stations may also pick up a couple of pictures on the pass preceding noon and on the one after noon—a total of seven. In the polar areas, stations will be able to receive a relatively large number of highly overlapping views of cloud patterns.

To effectively get these pictures, ground stations will have to have an ephemeris of the satellite's orbit. Herbert Butler, Goddard's associate chief for projects, aeronomy and meteorology div., told MISSILES AND ROCKETS that such an ephemeris may be sent out at weekly intervals. In this way, the stations would have information to get three pictures fairly easily: at *Nimbus*-rise, at zenith, and at *Nimbus*-set.

This means station operators will have to change antenna direction about twice each pass. To keep system cost low, Goddard does not expect ground stations to have tracking-antenna systems. Operators will depend mainly on signal-strength meters and their own reflexes to get the best reception.

Along with the ephemeris, station operators through their meteorological organizations will get NASA-furnished charts needed to identify the local areas covered by APT pictures. These tools, plus the prescribed several pieces of equipment and a timepiece accurate to within one second, will be sufficient for any weather station to get facsimile pictures from any APT on a *Nimbus*.

NASA officials heavily underscore, however, that APT is still experimental and except for facilities directly engaged in the program, no weather station is advised to procure any ground equipment for it.

• **APT a local system**—APT should not be confused with the fairly well known *Nimbus* Advanced Vidicon Camera System (AVCS). This is a highly sophisticated system that provides cloud-cover pictures of the sunlit side of Earth and consists of three TV cameras, a magnetic tape recorder and associated electronics.

Every 91 seconds, AVCS produces a three-frame composite picture measuring 450 miles along a line of longitude by 1450 miles along a line of latitude. The recorder contains a four-track magnetic tape to store the video outputs from the three cameras. The recorder is played back on ground command and the tapes are erased after every read-out.

APT, on the other hand, does not need ground-command equipment since it transmits continuously at fixed intervals; nor large-dish receiving antennas since the information is transmitted on a very narrow beamwidth.

The APT ground stations will get data uniquely suited to their needs; the information will come, moreover, in far greater detail and in better time than data from AVCS with its inherent processing and transmissal delays. The AVCS system, however, will play a dominant part in global weather forecasting.

• **How it works**—APT is a storage vidicon system utilizing long-duration storage and a very slow readout rate. Sequence of operation: a cloud picture is snapped; it is electronically scanned and transmitted over a three-minute period; another picture is snapped to begin the cycle again.

Major significance of this slow readout technique is the extreme bandwidth compression that can be obtained as a trade-off with transmission time.

The narrow bandwidth of transmitted information makes it possible for ground stations to use extremely simple and inexpensive equipment to receive the cloud pictures.

The cloud image is projected on a storage vidicon through a 108° lens. The exposed picture is stored electrically in the insulating layer of the storage vidicon target and is available for very slow readout.

The insulating or storage layer of the vidicon tube is polystyrene and the mesh is a very fine copper screen. The target potential is held constant and the mesh voltage is raised or lowered with respect to the target during the prepare, expose, and readout sequences. The vidicon has a number of reticles evaporated on the faceplate. These fiducial marks provide an accurate means for measuring linearity and are also used for alignment of the vidicon in the camera.

Transmission of the video information to the ground is accomplished by using the detected video signal to amplitude-modulate a 2400-cps subcarrier. The modulated subcarrier, in turn, is used to frequency-modulate the transmitter.

To accomplish automatic starting and phasing of the facsimile recorder, a start tone and phasing pulse are transmitted prior to the start of the picture itself.

All timing is controlled by the sequence timer, which operates from a 2400-cps signal from the satellite clock. Should the clock fail, an internal 2400-cps oscillator is automatically switched on to operate the system.

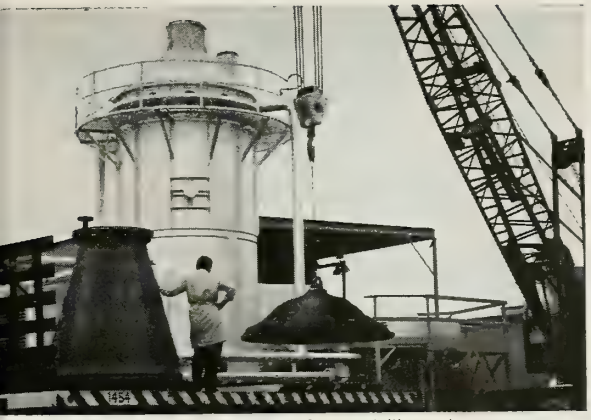
APT is turned off during the night portion of its orbit. ⁘



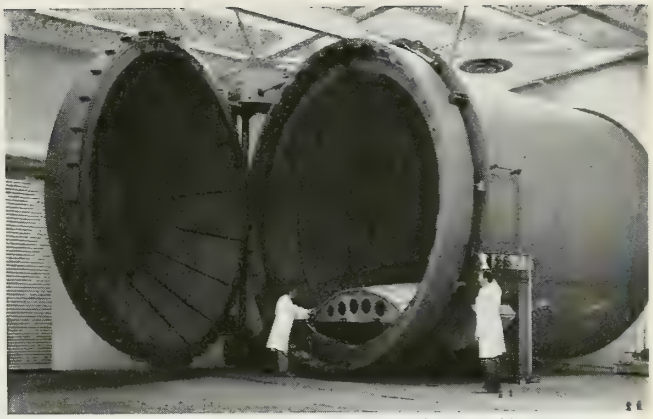

*'BOTTOM VIEW' of cloud cover processed in test of system.*




Circle No. 6 on Subscriber Service Card



Rohr-built hydroclave for fabrication of non-metallic nozzles



Rohr autoclave is largest of its type in the world



Brazed stainless steel honeycomb radiator-condenser for SNAP II

# The tools, the techniques and talent for building space flight structures

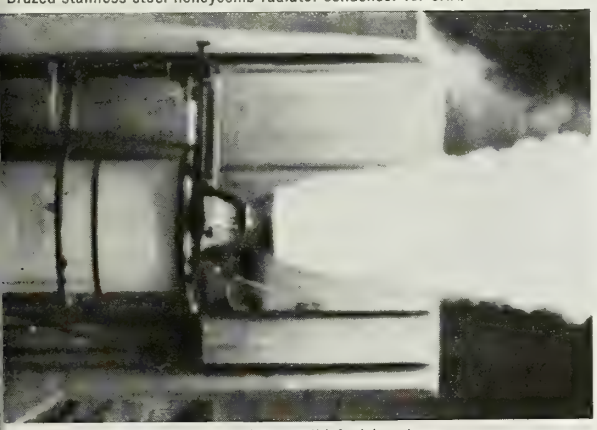
The products and production facilities pictured here prove Rohr's capability in the field of fabricating complex space flight structures. From ground support equipment to propulsion hardware to satellite components the capability is here. A unique combination of men, imagination and modern machines solving serious problems in manufacturing methods and materials. Address specific questions to Marketing Manager, Department 146, Rohr Corporation, Chula Vista, California.



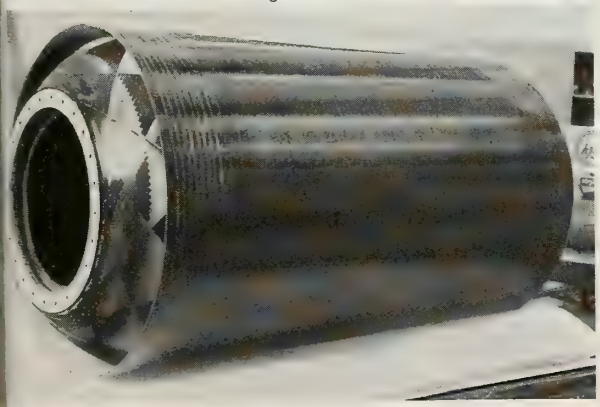
MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF. / PLANT: RIVERSIDE, CALIF. / ASSEMBLY PLANTS: WINDER, GA.; AUBURN, WASH.

ROHR CORPORATION

OFFICES IN WASHINGTON, D. C.; DAYTON, OHIO; HUNTSVILLE, ALA.; HOUSTON, TEXAS.

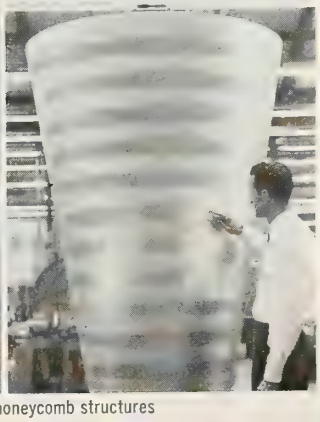


Laminated nozzle for large solid fuel booster

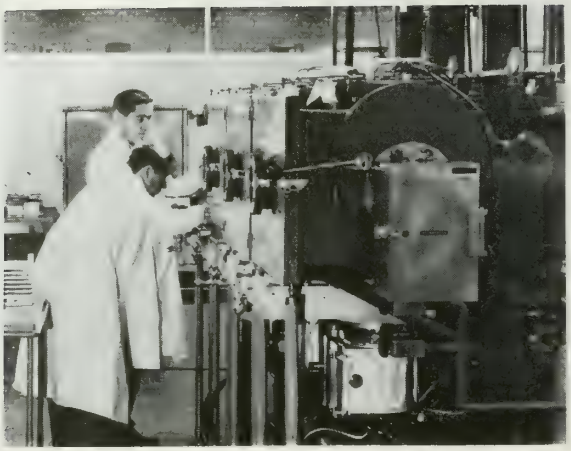


30 inch filament wound rocket engine case with skirt.





Advanced bonded honeycomb structures



*TECHNICIANS operate first system that produces thin-film electronic circuits continuously.*

space electronics

# IBM-built Navy System Advances Circuitry Art

UP TO 104 thin-film circuits are now being deposited on a single card with a fully automated continuous process on a prototype production facility built for the Navy.

Developed by International Business Machines Corp. under a half-million-dollar contract for the Naval Avionics Facility in Indianapolis (NAFI), the manufacturing system can turn out as many as 750 circuits per hour. Individual circuits often contain up to 3000 thin-film components, developers claim.

In mid-1961, NAFI awarded a contract to IBM's Federal Systems Div. to develop the experimental evaporation process system.

• **Four-stage deposition**—In the new IBM facility it is possible to fabricate passive microminiature thin-film networks continuously in a four-stage deposition. Glass substrates are transported mechanically through four interconnected vacuum chambers. Each chamber is separated from the loading magazines and source chambers by vacuum locks.

The chambers, measuring 2x2x1.5 feet, contain substrate conveyors, substrate heaters, and mask changers. Attached to each of these main chambers are smaller chambers containing the evaporation sources.

The pilot system evaporates four layers of material onto a 3-¾x5-3/16 in. plane substrate. Evaporation rate, substrate temperature, film thickness, chamber pressure, and transfer mechanism are precisely controlled. IBM says registration accuracy is better than ±0.002 inches.

Pumping components are mounted on transportable platforms and all valves are electro-pneumatically controlled. Chamber pressure during deposition remains between $5 \times 10^{-5}$ and $5 \times 10^{-6}$ Torr, IBM engineers report.

• **Typical process**—In the fabrication process, the transport mechanism positions masks and substrates inside the vacuum changer with a minimum of operator control. Also, the mechanism stores additional masks and substrates. It removes each substrate from the entrance magazine, transfers each through the four evaporation chambers, and then places the substrate in the exit magazine.

Twenty-four substrate holders are contained in each magazine, one above the other. No sliding friction occurs—all moving parts are mounted on ball-bearings—and no lubrication is required by the transport mechanism, developers say.

Up to six masks are stored in a cartridge in each chamber. A mask changer performs the functions of (1) removing a clean mask from the cartridge, (2) raising or lowering it to register with the substrate holder and (3) returning the "dirty" mask to the cartridge after a number of evaporations. The changer contains a heater to raise the temperature of the mask to that of the substrate. ⁘

## Ford Aeronutronic Wins NASA Lunar Camera Award

FORD MOTOR CO.'s Aeronutronic division has won a NASA contract for a camera system to be hard-landed on the lunar surface.

The camera will photograph the lunar landscape and relay the pictures to Earth.

The contract follows completion of an Aeronutronic study of the possibility of installing a camera scanning-and-transmission system in a 25-in. balsa wood ball developed for the *Ranger* program. The photo equipment would replace seismometers carried in *Rangers 3, 4* and *5*.

Aeronutronic studies revealed design and application of the compact system are entirely feasible.

The photographic equipment will be housed in a survival sphere floating in a liquid within the balsa wood impact limiter.

After impact, the interior ball will right itself by gravity and the fluid will be drained from the cavity between the two spheres to stabilize the inner sphere. As soon as this is completed, a hole will be punched in the other shell.

A telescoping mast will be extended through the hole to a point 30 to 32 in. above the lunar terrain. Equipment within the mast will then begin a 360-degree scan of the landscape that will take at least eight hours.

The terrain will be scanned in a series of vertical sweeps by a rocking prism in the mast. Each movement of the prism will cover 1/10th degree of the horizon and sweep the landscape from five degrees above to 30 degrees below the horizon. The photo will be in focus from 30 in. to infinity, and be able to distinguish grains of sand in the foreground.

The scanned image will be conveyed down the mast to a photoelectric cell by a series of mirrors and lenses. The photocell will convert the varying light intensities into electrical current fluctuations. These will be broadcast simultaneously to Earth.

The signal will be converted into light variations, which will be recorded on a photo lathe similar to those now used in wire transmission of news photos. The 3600-line photo will permit extremely high resolution. ⁘

# EMR Gemini Award

## PCM Telemetry Is in Million-Dollar Class

THE PCM (Pulse Code Modulation) telemetry system for *Gemini* will be developed by Electro-Mechanical Research, Inc., under a recently announced "multi-million dollar" contract awarded by McDonnell Aircraft Corp., prime contractor to NASA for the two-man space capsule. The contract includes the flight data-transmission and recording systems and all associated ground checkout subsystems.

To meet the *Gemini* system's reliability requirement of 0.93 (or 93% prediction of success), EMR officials told M/R that the onboard system will make extensive use of series and parallel redundancy and minimum-power logic circuits.

The EMR system, which includes the PCM data-handling system, tape recorder, and transmitter, will be designed for high accuracy for telemetering spacecraft performance parameters such as vibration and temperature, biomedical data, and computer digital output data from spacecraft guidance and control systems.

It will accept both high-level (0-5 volts) and low-level (0-20 mv) data inputs and interlace data and computer words. Data words, said EMR, are quantized to eight bits and output is in series form, available for tape recording and transmitter modulation. Nominal bit rate is 50 kc, the company said.

The PCM telemetry system will be used to relay crew reaction to long-duration space flight and internal and external spacecraft environment measurements to ground stations.

It will also record and transmit data pertaining to the rendezvous and docking operations between the *Gemini* spacecraft and an *Agena* target vehicle.

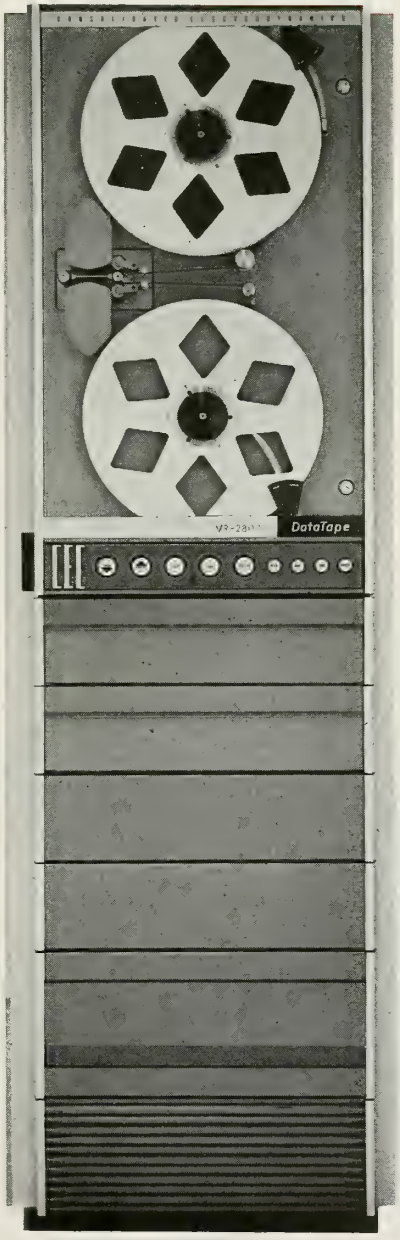
Checkout equipment to be supplied to McDonnell will include units for automatically checking and qualifying the spacecraft telemetry systems and performing pre-delivery and pre-flight checkout of the data-transmission system.

Automated checkout of a complete spacecraft telemetry system will be provided in less than five minutes.

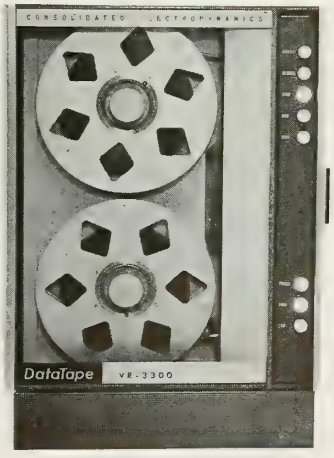
*Gemini* spacecraft checkout will be performed by means of an EMR high-speed PCM ground station, the company said. This station will be capable of handling a very wide range of PCM signal formats and data rates. It will supply both serial and parallel binary and bcd outputs in various forms for tape-recording. ⁂


# Just released!

## (For Direct and FM Techniques)




**CEC's New Wide-Band Magnetic Tape Recorder/Reproducer Systems** give you twice the capability of information storage as conventional machines. Bandwidth: 100 cycles to 200kc, direct—0 to 20 kc, FM. 6 speeds. Solid state throughout for low power consumption and weight. Type VR-3300 is the portable model and Type VR-2800 is ideal for data gathering in lab, van, shipboard and blockhouse environments. For complete information and specifications, call your nearby CEC office or write for Bulletins CEC 2800-X21 and 3300-X14.




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Circle No. 11 on Subscriber Service Card

# Glass To Be Used in MMRBM Cases

by John F. Judge

THE AIR FORCE'S *Mobile Mid-Range Ballistic Missile* will use glass filament-wound cases in all stages—making it the first major weapon system to adopt non-metallics in its initial development.

Other pertinent points made at a recent Air Force symposium on structural plastics, adhesives and filament-wound composites held in Dayton included:

—Grudging acceptance of the finality of titanium for the second stage *Minuteman* case even though winding experts claim a 50% cost advantage over the high-priced metal. This is in spite of the modulus problem associated with filament-wound cases in the Boeing *Minuteman*—a problem recognized by proponents of reinforced plastics.

—Indications that the problems plaguing Lockheed's *Polaris A-3* are not connected to its reinforced plastic structure.

—Details of a new non-destructive testing method for detecting structural flaws in filament-wound motor cases.

The technique, developed by Goodyear Aircraft Corp., (M/R, Oct. 1, p. 26) was covered by R. A. Burkley and T. J. Boller.

• **Process detailed**—Goodyear's method involves a vapor-deposition coating process. Certain of the continuous glass roving strands are coated with an electrically conductive metallic film. Damage is indicated through a change in resistance, or by the open circuit that results from complete filament breakage.

Strand-test measurements with coated and uncoated rovings from the same package showed only a slight strength loss for the coated roving. Even this loss might be eliminated, says Burkley, by an improved coating technique. The vacuum-deposition process has this potential, and a machine can be produced that is capable of depositing a 0.000001 in. aluminum coating in a high-speed continuous process.

Demonstrating the feasibility of the method involved a 6-in. test bottle with coated-filament circuits incorporated in the outer hoop and in longitudinal windings.

Because of the short 18-in. lengths used, Goodyear researchers could not wind them into a complete layer as they would be able to do in full-scale application. But three hoop circuits and a single longitudinal circuit served the purpose of the test.

• **Destruction test objectives**—The final test consisted of a deliberate burst with rupture at 1400 psi. Continuity in the test circuits was maintained until failure. The test had two objectives:

—To determine the performance characteristics of a tracer element in a structure.

—To verify that the tracer element will remain electrically active until failure occurs and that it will respond electrically to structural discontinuities when the composite is strained.

While the single test did not conclusively meet these targets, it did indicate sequential failure of the tracer element—as would be expected of all glass-roving reinforcements. It also showed compatibility between the basic tracer element and the composite.

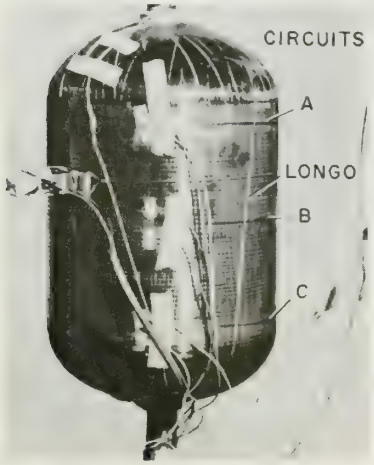
Burkley says the most significant data obtained from the test might well be the rate of change in resistance of Circuit B (see below) during the burst test. Observation located the initial failure in the central region of the specimen—approximately the area covered by Circuit B.

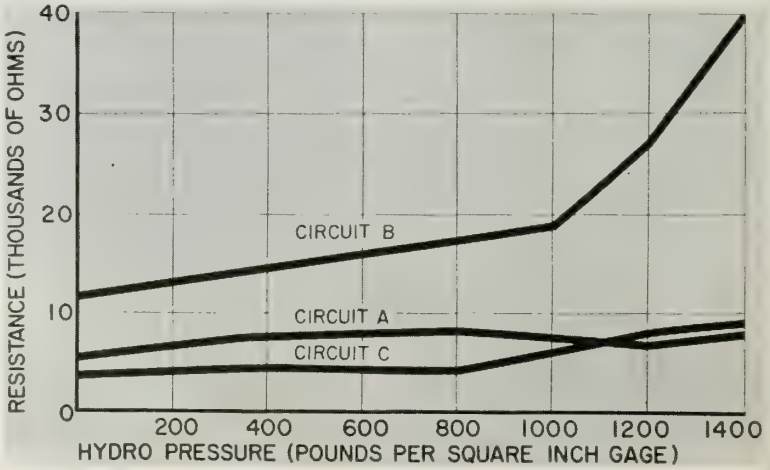
While little or no change in resistance was measured in Circuits A and C, the asymptotic change measured for Circuit B occurred well in advance of failure pressure—indicating detection of the weakest region before reaching burst pressure.

Analysis of the cycle-pressure test data indicates the possible prediction of failure in filament-wound structures subjected to repeated loading. This is based on the progressively increasing tracer-element resistance measured with each successive load cycle in the hydrotests.

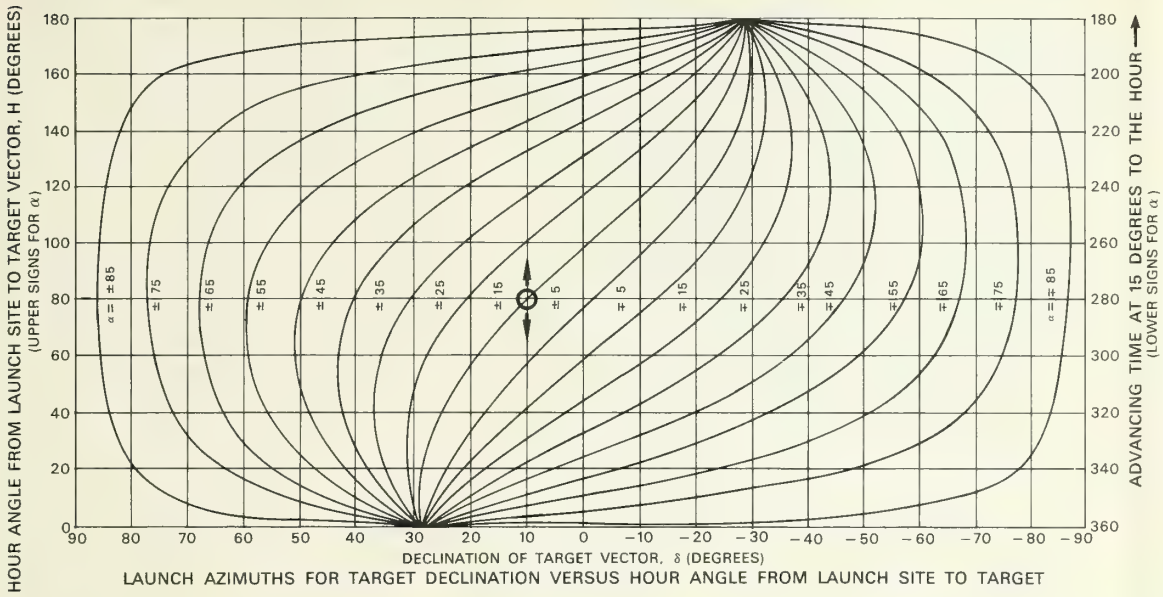
Burkley says more work is required to validate these findings, and investigations are in process to develop improved methods of flaw detection. ⁘

*THE SIX-INCH bottle at left hydrotested to 960 psi internally, imposing a wall stress of 80,000 psi. The test series showed the compatibility between the basic tracer element and the composite. The failure region was covered by Circuit B.*



# LUNAR LAUNCH · JULY 17, 1968




LAUNCH AZIMUTHS FOR TARGET DECLINATION VERSUS HOUR ANGLE FROM LAUNCH SITE TO TARGET

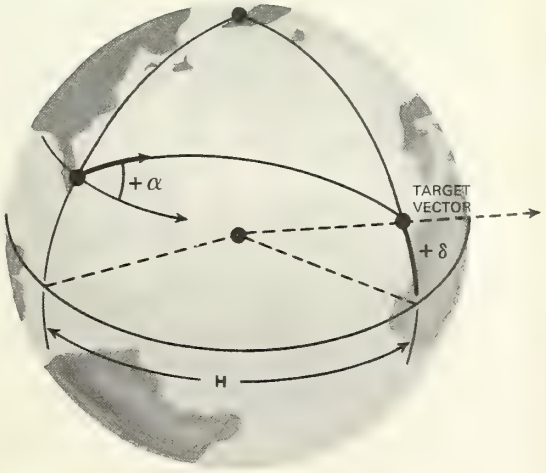
How do you launch into a geocentric planar trajectory from Cape Canaveral to a specified target vector? This family of curves demonstrates the interrelationships of the target vector declination, equatorial hour angle and launch azimuth. They can be used to estimate the launch requirements of lunar probes. For example, suppose a lunar vehicle launch is scheduled for July 17, 1968. At this time the declination of the moon will be $+10^\circ$ (NASA Technical Note D-911). Assuming an hour angle of $80^\circ$, the launch azimuth can be found to be $+5^\circ$. The azimuth change for a $\pm 1$ hr. launch window ($\pm 15^\circ$ in H) will be $\alpha = -2^\circ$ to $+12^\circ$ as can be determined by moving along the $\delta = 10^\circ$ line.

# ENGINEERS:

Plotting complex launches to the moon and planets is among scores of space-oriented activities in progress at Astronautics. We're also deeply involved with the development and design of boosters and vehicles for space exploration and travel. We're developing, too, the incredibly precise electronic systems necessary to guide and track and communicate with these probes.

Our constantly expanding efforts have created a number of outstanding positions for engineers with exceptional ability. If your interests and experience qualify you—if you'd like to work mind-to-mind with the top technical talent of the space age—we urge your immediate inquiry.

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics| Astronautics, 5801 Kearny Villa Rd., San Diego 12, California.

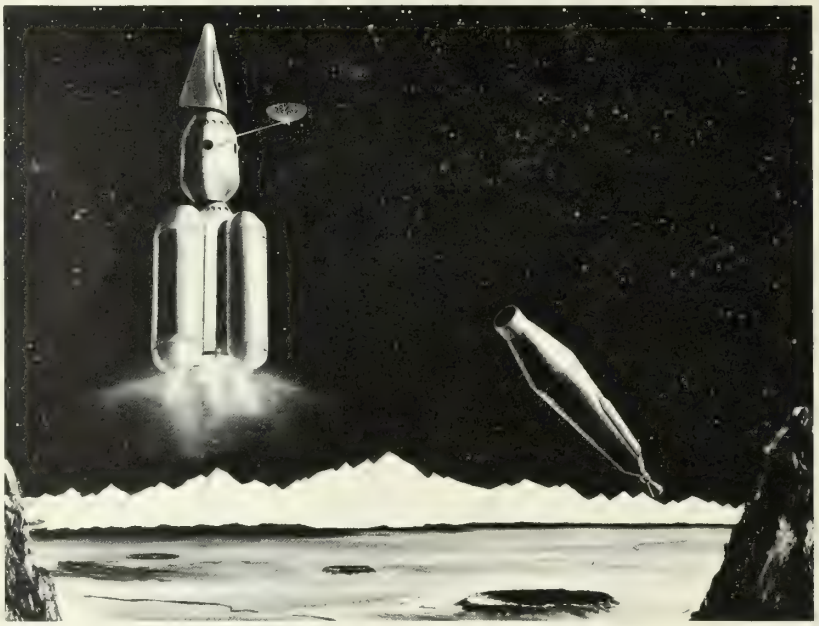



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**LUNAR LANDING** This spacecraft conceived by General Dynamics | Astronautics is shown backing down onto the lunar surface, controlled by powerful retro-rockets, after its journey from the earth. The discarded second-stage fuel tank is shown at right. Large tanks, clustered at base of the capsule and clam-shell re-entry glider vehicle, provide fuel for landing on the moon and take-off power for return to earth. The tanks also provide a measure of protection against space radiation for the crew. Rockets are arranged at slight angles to the craft to avoid problems in landing which might be caused by "digging" holes in the surface of the moon.



## DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

## AEROTHERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

## FLIGHT MECHANICS

Analytically talented graduate engineers at all levels required for staffing of new Flight Mechanics Development Section. Programs include aerospace vehicle guidance and automatic control, aeroelasticity, and aerophysics. Responsibilities of the Section also involve technical analyses and simulation work in support of all space vehicle programs at Astronautics.

## ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, nuclear-propelled space vehicles, earth-to-moon logistics bus, and space stations. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is required.

## GUIDANCE AND TRAJECTORY ANALYSIS

Positions exist in the following three areas for specialists who are familiar with computer techniques, possess a degree in engineering, physics, or mathematics, and have at least two years of appropriate experience:

1. Development of guidance equations and techniques necessary to perform launch, satellite rendezvous, lunar landing, re-entry, and return to prescribed earth sites. Will investigate both automatic and manual techniques, and define the proper role of man in these maneuvers. Assignments also involve the development of techniques for defining optimum trajectories for aerospace missions using the calculus of variations, dynamic programming, and the method of gradients, plus the incorporation of optimization techniques into the development of guidance equations.

2. Investigation and organization of characteristics of lunar and interplanetary trajectories. Will interrelate such parameters as velocity requirements, launch window, time of flight, inclination angles, and trajectory characteristics at the target body. Will also design trajectories to satisfy prescribed mission requirements.

3. Development of techniques for determining the best estimate of spacecraft position and velocity from optical and radar measurements within the confines of a spacecraft computer using statistical filtering.

## OPERATIONS AND SYSTEMS ANALYSIS

Projects involve the study and development of advanced ballistic missiles and boosters, plus both military and non-military orbital and space systems. Responsibilities include advanced systems planning, conceptual design, and systems evaluation. Advanced degree preferred; three years of appropriate experience required.

## ADVANCED SYSTEMS WEIGHTS ENGINEERING

BS in engineering with four years of experience in system and component weight allowances and controls. Will work with predesign on parametric weight analyses and design weight and balance control.

Graduate engineers will also find long-range opportunities in the following specialties: STRUCTURAL DESIGN, RELIABILITY, STRESS ANALYSIS, ELECTRONIC DESIGN AND DEVELOPMENT, MECHANICAL DESIGN, WELDING ENGINEERING.

*If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5801 Kearny Villa Road, San Diego 12, California.*

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***Fund increase put off . . .***

# Core Retention Problem Snarls Rover

***Officials fear technical difficulties could cause long stretchout; NERVA, RIFT affected***

by Russell Hawkes

LAS VEGAS, NEV.—The problem of keeping a nuclear rocket from spitting its fuel elements out the nozzle is the biggest and most difficult technical stumbling block now threatening the future of nuclear rocket Project *Rover*.

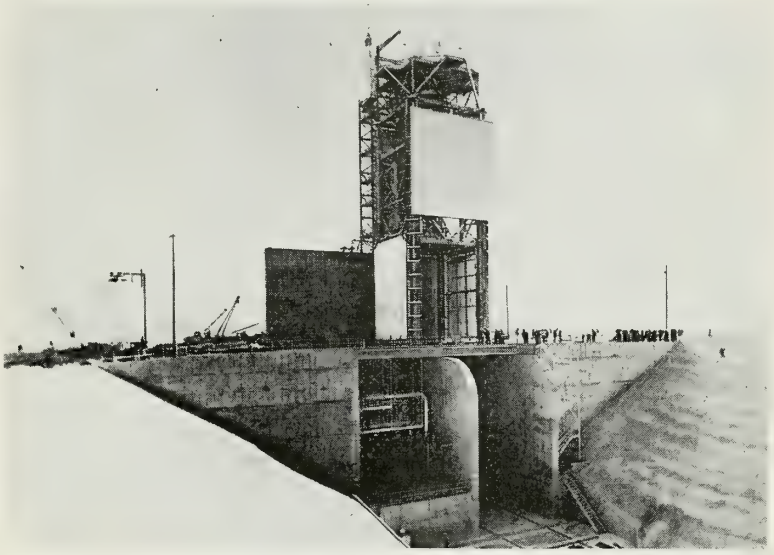
A request to raise the funding rate of the project from $200 million per year to $380 million has been rejected by President Kennedy until July, when he will reconsider the question in the light of progress made toward the solution of key technical questions by that date. Contractor officials and engineers working on the project are seriously concerned with the possibility that the nuclear rocket program will face a severe stretchout at that time if important progress cannot be shown on the main technical problems revealed in the tests of Kiwi flightless reactors at the Nuclear Rocket Development Station here.

Some nuclear scientists deprecate the problem of retaining the reactor core in the thrust chamber environment as "a simple mechanical engineering problem," but a publication of Los Alamos Scientific Laboratory, prime contractor for the Kiwi series, lists core retention as the toughest unsolved problem.

The dynamic pressure of in-flowing hydrogen propellant on the face of the reactor core is on the order of 1000 psi. Temperatures rise to a maximum of about 4500°F at the tail of the reactor core. The tubular hexagonal fuel elements of which the core is constructed are made of a ceramic uranium compound. A frequent feature of the six Kiwi reactor tests has been a shower of glowing pieces of this material.

• **Bind on Rover**—Like some other space programs, *Rover* is caught in the squeeze between the Administration's strong commitment to the manned lunar landing program and plans for a major tax cut. The MLLP is facing growing cost overruns. Unmanned lunar programs now are being defended on the grounds that they will supply needed information for the Project *Apollo* manned landing.

The nuclear rocket happens to show its biggest returns in advanced planetary missions, for which it improves the payload of an advanced *Saturn* launch system by a factor of 10 compared to the same launch systems using only chemical-powered stages. It can also double lunar payloads, but budget cutters point out that the first landings will be accomplished without the nuclear stage anyway. If there is no stretchout, the first nuclear rocket test flights are scheduled for late 1967.



*ENGINE Test Stand No. 1, designed by Aetron Div. of Aerojet, will test NERVA.*

There is a six-month lag in the schedules of the Kiwi phase of the program, which is supervised along with the rest of Project *Rover* by the joint AEC-NASA Space Nuclear Propulsion Office (SNPO). Since nuclear rocket technology is very new, there is little that can be done concurrently on the phases of the program that come after Kiwi. But this troubles SNPO boss Harold Finger very little, as he prefers step-by-step progress.

However, work on flyable *NERVA* (Nuclear Engine for Rocket Vehicle Applications) cannot proceed very far until the Kiwi phase yields a satisfactory reactor design. In turn, design decision on the *RIFT* (Reactor In Flight Test) airframe which will be powered by the engine must await more detailed knowledge of the characteristics of *NERVA*.

A NASA official told MISSILES AND ROCKETS that the *RIFT* phase of the program being conducted under contract by Lockheed Missiles and Space Co. seems to be the most likely target for any stretchout because its end-point is more distant than those of the engine and reactor program. He said NASA is highly pleased with Lockheed's conduct of the program thus far.

• **New Kiwis**—Two new flightless reactor series are presently scheduled to enter the program next year. They are called Kiwi 5 and Kiwi 6. The former is a direct descendant of earlier Kiwi reactors; the latter is based on an alternative technical approach to problems of reactor core retention. Kiwi 6 will be conducted by the contractor team of Aerojet-General Corp. and Westinghouse Electric, rather than by LASL.

One industry official has attributed schedule troubles to acceptance by LASL of a tight schedule for development of a system far beyond the technology then existing. An example of how Kiwi delays have disjointed the program is to be seen in the fact that the $20-million Engine Test Stand No. 1 (ETS-1) for *NERVA* firings will be essentially complete by March, 1963, while the engine itself cannot be available for tests before late 1964. ⁂

# Executive Pay Decline Continues

EXECUTIVE SALARIES in the missile/space industry continued on a downward path through 1961, establishing a four-year trend.

Recently released figures indicate that top management received 5.2% less compensation in 1961 than in 1960—a distinct parallel with a 9.2% decline in profits during the same period.

These figures are part of the eighth annual executive compensations study prepared by McKinsey and Co., Inc., a management consulting firm. Based on data filed with the Securities and Exchange Commission, the study encompasses 475 companies in 25 separate industries.

The missile/space sampling covered 20 major manufacturers. It did not include companies whose major effort is in electronics.

In 1961, missile/space executives fared poorly, as compared to those in other industries surveyed. In only one of the 25 industry groups covered—non-ferrous metals—was the decline in executive compensation sharper than in aerospace; and only four groups—automotive, electronics, steel and textiles—showed greater declines in profits.

According to the study, the current depressing profit and compensation trends began in 1957; since that time, profit has plummeted 50%. Over the same years, industry in general has managed to achieve a profit improvement of about 2%.

Since 1957, aerospace executive pay has plunged 10% while industry in general has shown a 5% rise in such compensation. Another, related figure for the period is a slight net rise in sales for aerospace of 2.8%—contrasted to an overall industry rise of 11%, on the average.

• **Subcategories**—McKinsey divided the companies chosen for the survey into two subcategories airframe and non-airframe.

Though traditional lines between segments of the industry are becoming increasingly blurred, companies that either have left airframe manufacture or have continued as subsystem contractors were compared with those continuing to produce government or commercial aircraft.

Comparison of the two subgroups discloses a substantial absolute compensation spread between them. Chief executives in the airframe category ran companies roughly twice as large as did counterparts (on the same compensation level) in the non-airframe group.

Per dollar of sales volume, non-airframe executives received about 25% more pay than airframe top executives. And whereas non-airframe compensation on the top levels is about average for industry as a whole, pay to airframe chiefs is substantially below the all-industry average.

For example, for an annual sales volume of $400 million, airframe compensation might be about $105,000, and non-airframe would reach $130,000; for sales of $1 billion, top airframe pay might be $135,000, as contrasted to $170,000 for non-airframe chief executives.

Again, there is a similar contrast in profits between the two groups. For each of the past two years, the airframe group showed a cumulative loss, while the non-airframe profit was about 3.8% on sales. And in 1958 and 1959, the few firms in question that showed a loss were in the airframe subgroup.

An interesting contrast between the two categories regards turnover in chief executive positions. In 1960-61, 36% of the airframe executives and 22% of the non-airframe executives in this industry were new on their jobs. These rates far exceed the 12% top-executive turnover for industry in general.

The study does point to a "significant" number of aerospace industry executives who have held their posts for at least 10 years, however.

• **The big four** — The McKinsey survey included the chief executive officer and his three most highly paid subordinates in each firm. These subordinates received better pay in comparison to their chief executive than did their counterparts in industry as a whole—only the lowest-paid of the three was not awarded a percentage of his chief's pay figure higher than that of his all-industry counterpart.

In the airframe category, the number-two man received about 82% of his chief's pay figure, as contrasted to 72.5% in non-airframe, and 70.9% in industry generally. For the number-three man: airframe, 63.7%; non-airframe, 63.4%; and all-industry, 58.7%. For the number-four executive: 54.8% in airframe, 47.7% in non-airframe, and 53.7% in industry generally.

Airframe chief executives themselves received compensation so far below non-airframe and all-industry averages, however, that their immediate subordinates still received less than the average pay for comparable positions elsewhere. ⌗

## Typical Chief Executive Salaries

| Official | Basic Salary and Fees | |
|---|---|---|
| | 1960 | 1961 |
| William B. Bergen, President Martin Co. | $100,000 | $100,000 |
| Mundy I. Peale, President Republic Aviation | 131,166 | 139,766 |
| William P. Gwinn, President United Aircraft Corp. | 176,800 | 176,260 |
| D. A. Kimball, President Aerojet-General Corp. | 95,000 | 100,000 |
| M. P. Ferguson, President Bendix Corp. | 161,850 | 160,700 |
| William M. Allen, President Boeing Co. | 115,901 | 99,989 |
| D. W. Douglas, Jr., President Douglas Aircraft Co. | 87,675 | 91,425 |
| Albert E. Forster, President Hercules Powder Co. | 184,621 | 179,030 |

*M/R chart based on estimates from Securities & Exchange Commission records.*

## Apollo Launch Facility Designed

Urbahn-Roberts-Seelye-Moran (URSAM) is the combined name adopted by four New York City firms for design of facilities at Complex 39, NASA's new Launch Operations Center for *Apollo,* at Merritt Island (Cape Canaveral), Fla.

More than 200 engineers now are preparing plans and specs for the gigantic main building, which will be more than 500 ft. tall, cover more than 10 acres and include about 130 million cu. ft. of working space for a predicted total of 2500 employees. Construction bids will be solicited next spring for the assembly building, which is expected to cost over $100 million.

Under the supervision of Col. J. V. Sollohub, District Engineer, Jacksonville District of the Army Corps of Engineers, the URSAM design team includes the offices of: Max. O. Urbahn, architect and managing partner; Roberts & Schaefer Co., Inc., structural design; Seelye, Stevenson, Value & Knecht, Inc., civil, mechanical and electrical plans and specs; and Moran, Proctor, Mueser & Rutledge, foundation analysis and designs.

Multiple assembly methods for *Apollo* are expected to result in substantial time and money savings, as it will be possible to erect, mate and check out vehicles simultaneously and fire the rockets in quicker sequence than is now possible; present procedures often require a tie-up of the pad during mating and checkout.

## Other Industry Facilities

Geotechnical Corp. has finished work on its "stable table" to test inertial guidance components for *Minuteman, Atlas* and *Titan.* Mounted in a four-story underground structure at Newark Air Force Station, Ohio, the 7-ft.-sq. table is suspended like a pendulum and is isolated from the influences of temperature, magnetic fields, humidity, and Earth motion, as well as disturbances as minute as a slight breeze against the housing building. Suspension system employs spring-like devices of beryllium specially fabricated by Beryllium Corp., Reading, Pa. . . . *Process Equipment and Automation, Inc., has completed work on an atmosphere conditioning system to be an integral part of a multimillion-dollar escape simulator under construction for Aerospace Medical Research Laboratories. The completed system has passed checkout and demonstration tests before installation at Wright-Patterson AFB, Ohio.* . . . Douglas Aircraft Co. will build a missile/space advanced research center on a 10-acre site in Huntington Beach, Calif. Site of the $2 million laboratory was acquired by Douglas last July for its Space Systems Center, now under construction. . . . *Missile/space laundry and dry cleaning are a thing of the present, what with Prudential Overall Supply's newest garment-processing laboratory. The Commerce, Calif., firm's recently opened facility is equipped and controlled to meet stringent clean room requirements, and is designed primarily to serve markets in precision electronics and related missile/space activities.* . . .

## Cryonetics Corp. Set Up

Richard S. Morse, former president of National Research Co., has set up Cryonetics Corp. of Burlington, Mass., to specialize in cryogenic research and equipment development. Morse will be chairman of the new firm's board of directors.

A special scientific advisory board for the company will be manned by: Dr. Edward Teller, professor-at-large, University of Calif.; Prof. Courtlandt T. Perkins, Chmn., Aeronautical Engineering Dept., Princeton University; and Dr. Wilhelm F. Gauster, head of the Engineering Science Group, Thermonuclear Div., Oak Ridge National Laboratories.

Dr. James Nicol, director of research for Cryonetics, outlined two of the firm's planned projects. The first is development of a laboratory refrigerator for research on materials at controlled temperatures within 1° of 0°K (−459.69°F). The second program is directed toward development of a miniature refrigerator suited to missile/space applications and providing an ultra-low-temperature environment for electronic components and sensors.

The firm now has laboratory and plant facilities in Burlington; offices in Washington, D. C.

## International News Notes

Coordinated firings of *Skylark* sounding rockets were conducted in Australia and Argentina recently, in one phase of an upper-atmosphere wind study program organized by the Committee on Space Research (COSPAR). Coordination of the various firings throughout the world is being carried out by NASA. . . . *In a move toward selling more of its services and technical know-how in Europe, Lockheed has reorganized its wholly owned Swiss subsidiary, Lockheed Aircraft International AG originally formed in 1960.* . . . Europe's non-profit space development organization, Eurospace, has acquired three new collective members and 15 new active members. The collective members are: ANIE (Italy); Belgospace (Belgium); and Verband der Chemischen Industrie (Germany). New active members are: AEG (Germany); Ateliers et Forges de la Loire (France); Belgonucleaire (Belgium); Compagnie Electro Mecanique (France); Crouzet (France); Dunlop (U.K.); Galileo (Italy); Gasdynamik (Germany); Interatom (Germany); Retec (France); Rheinmetall (Germany); Rhone Poulenc (France); SAF (France); TRT (France); and Trefileries et Laminoirs du Havre (France). Four U.S. and two French companies are new corresponding members of Eurospace: Aerojet-General; Douglas; General Electric; North American Aviation; Credit Lyonais; and Banque Commerciale de Paris.

# contracts and procurements

## AWARDS

### AIR FORCE

$16,915,000—**General Dynamics Corp.,** New York City, for work in connection with the installation and checkout of *Atlas* missiles. Work to be done at San Deigo, Calif.

$9,000,000—**International Telephone and Telegraph Corp.,** New York City, for fabrication and delivery of electronic equipment (supplemental contract). Work to be done at Paramus, N.J.

$3,350,000—**International Business Machines Corp.,** Bethesda, Md., for work on data-processing equipment.

$3,000,000—**Hallicrafters Co.,** Chicago, Ill., for work on a classified project.

$2,850,000—**General Electric Co.,** New York City, for design and fabrication of *Titan II* intersite communications equipment. Work to be done at Lynchburg, Va.

$2,300,000—**Hughes Aircraft Co.,** Culver City, Calif., for development of fire-control system for the *GAR-9 Falcon* missile.

$2,229,002—**Aerojet-General Corp.,** Sacramento, Calif., for production of *Titan II* missile propulsion systems.

$1,512,000—**Sylvania Electric Products, Inc.,** New York City, for ground-support equipment for electronics equipment. Work to be done at Mountain View, Calif., and Waltham, Mass.

$1,500,000—**Hercules Powder Co.,** Kensville, N.J., for rockets for *Minuteman* missiles.

### ARMY

$4,240,469—**General Dynamics Corp.'s Pomona, Calif., division,** for research and development of the *Mauler* program.

$3,000,000—**General Electric Co.,** Syracuse, N.Y., for high-power radar for the *Nike-Hercules* system.

$2,742,980—**Bell Aero Systems Corp.,** Buffalo, N.Y., for electronics to modify a guidance equipment system.

$2,020,724—**Northrop Corp.'s Nortronics Div.,** Anaheim, Calif., for 1989 sets of *Hawk* wing assemblies.

$2,000,000—**General Electric Co.,** Syracuse, N.Y., for retrofit kits for the *Nike-Herclues* system.

$1,663,050—**Rohm and Hass Co.,** Philadelphia, Pa., for continued basic research on solid-propellant rocketry.

### NAVY

$7,252,000—**Lockheed Missile and Space Co.,** Sunnyvale, Calif., for engineering and other services on *Polaris* missiles.

$4,583,000—**Sperry Rand Corp., Sperry Gyroscope Co.,** Great Neck, N.Y., for field engineering services for fire-control equipment for *Talos* and *Terrier* missiles.

$3,198,920—**General Dynamics Corp., General Dynamics/Electronics,** Rochester, N.Y., for sonobuoys.

### DOD

$1,300,000—**Aeronca Manufacturing Corp.,** Middletown, Ohio, for design, research, development and production of electronic and airframe components for aircraft, missile and space programs.

### NASA

$1,500,000—**Thiokol Chemical Corp., Wasatch Div.,** Brigham City, Utah, for hypervelocity aerodynamic test units for the Ames Research Center.

$1,500,000—**Fairchild Stratos Corp.,** Hagerstown, Md., for two prototypes and 40 production models of ground stations to receive and present weather data from satellites.

### INDUSTRY

$2,712,888—**The Ross Corp.,** New Orleans, from **Mason-Rust,** for construction of a vertical assembly, hydrostatic test and cleaning facility for the *Saturn S-1C* booster.

$1,250,000—**Minneapolis-Honeywell Regulator Co.,** Hopkins, Minn., from **Boeing Co.,** for electrical power equipment for the *Minuteman* missile.

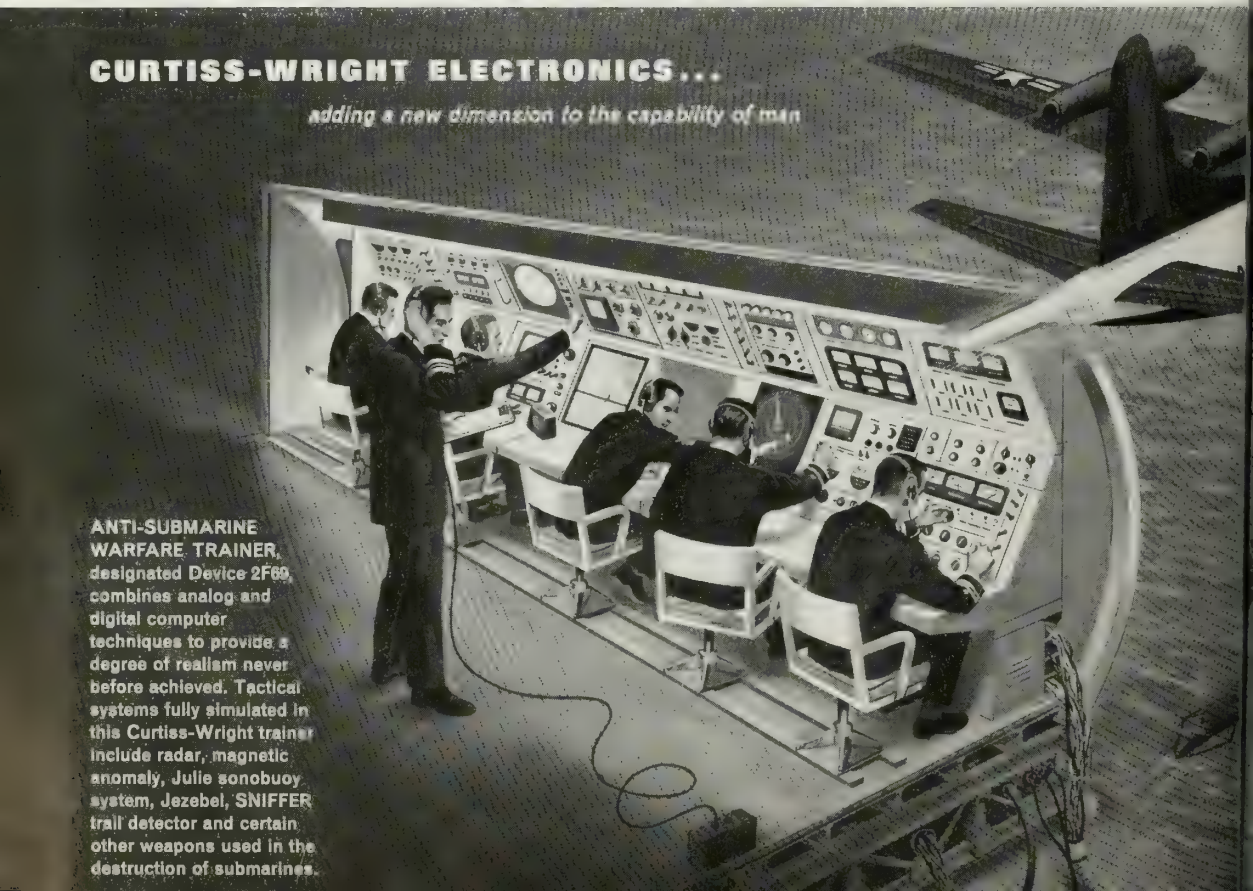
$1,000,000—**Pacific Semiconductors, Inc.,** Hawthorne, Calif., from **Boeing Co.,** for standard diodes for use in *Minuteman* ground-support equipment.

$500,000—**Lear-Siegler, Inc.'s Astro Structures Div.,** El Segundo, Calif., from **Philco Corp.,** for a satellite-tracking antenna project.

$170,000—**General Electric Co.,** New York City, from **Boeing Co.,** for capacitors for use in the *Minuteman* program. Work to be done at Irmo, S.C.

**Ford Motor Co.'s Aeronutronic Div.,** Newport Beach, Calif., from **Jet Propulsion Laboratory,** for a space capsule scanning system (undisclosed amount).

**Westinghouse Electric Corp.,** Pittsburgh, from **North American Aviation's Autonetics Div.,** for microminiaturized integrated electronic circuits for use in the *Improved Minuteman* program (undisclosed amount).

## GENERAL PROCUREMENTS

# REQUESTS FOR BIDS

Hercules Project Office
U.S. Army Missile Command
Redstone Arsenal, Ala.

The Army Missile Command proposes to procure from Intercontinental Manufacturing Co., Garland, Tex., services in connection with the rehabilitation of M30 rocket motor metal parts for the *Nike-Hercules* missile. This synopsis is to publicize possible subcontracting opportunities and all inquiries relative to subcontracting must be referred to Intercontinental Manufacturing Co. Do not contact the U.S. Army Missile Command with respect to this procurement.

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U.S. Army Missile Command
Procurement and Production
Special Contracts Branch
Redstone Arsenal, Ala.

Selected source procurement for continuity of research effort in advanced solid-rocket propellents in accordance with classified scope of work, TR-SR-228, for 12-month period with Olin Mathieson Chemical Corp., New Haven 4, Conn. This requirement is synopsized only for the purpose of affording subcontracting opportunities through direct inquiry to the prime contractor.

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Research and Development Procurement Office
U.S. Army Engineer Research and Development Laboratories
Fort Belvoir, Va.

It is proposed to negotiate a contract with Autometric Corp., New York, N.Y., for the fabrication and testing of two equatorially mounted Star satellite cameras. This firm has previously accomplished the successful design of the camera which is of a proprietary nature. This notice is for information only and RFQ AMC(T) 44-009-63-1790B is not available.

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Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Negotiations will be conducted with the Philco Corp., C and Ontario Sts., Philadelphia 4, Pa., for services for the reduction and evaluation of optical data obtained from missile reentry programs under contract NAS 1-2127. Note: For information only; no RFP available.

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Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Single source procurement covering services and materials necessary to modify and upgrade Fitgo amplifiers manufactured by Beckman Instruments, Inc., as part of a recording system. RFP L-2847. Proposals requested by close of business 1-11-63.

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Direct Support (Guided) Division
Directorate of Procurement and Production
U.S. Army Missile Command
Redstone Arsenal, Ala.

This is not a request for proposals. This synopsis covers a procurement for the continuation of research and development of the *HAW (TOW)* system by the Hughes Aircraft Co., Culver City, Calif. The items being procured for a development program must be fabricated from manufacturer's design drawings and supporting documentation which precludes award to other than the prime contractor. All inquiries relative to subcontracting must be referred to Hughes Aircraft Co., Culver City, Calif.

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Directorate of Procurement and Production
Olmsted AFB, Pa.

Non-personnel services to provide assistance in establishing an organic depot facility for the overhaul and repair of astroinertial instrument systems for the GAM-87 *(Skybolt)* missile—approximately three industrial engineering man-months. Negotiations will be conducted with Nortronics Div., Northrop Corp., Hawthorne, Calif. For information only. No RFP available.

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National Aeronautics and Space Administration
Ames Research Center
Moffett Field, Calif.

Negotiations will be conducted with Packard Instrument Co., for one automatic liquid scintillation spectrometer and accessories. Note: For information only. RFP not available.

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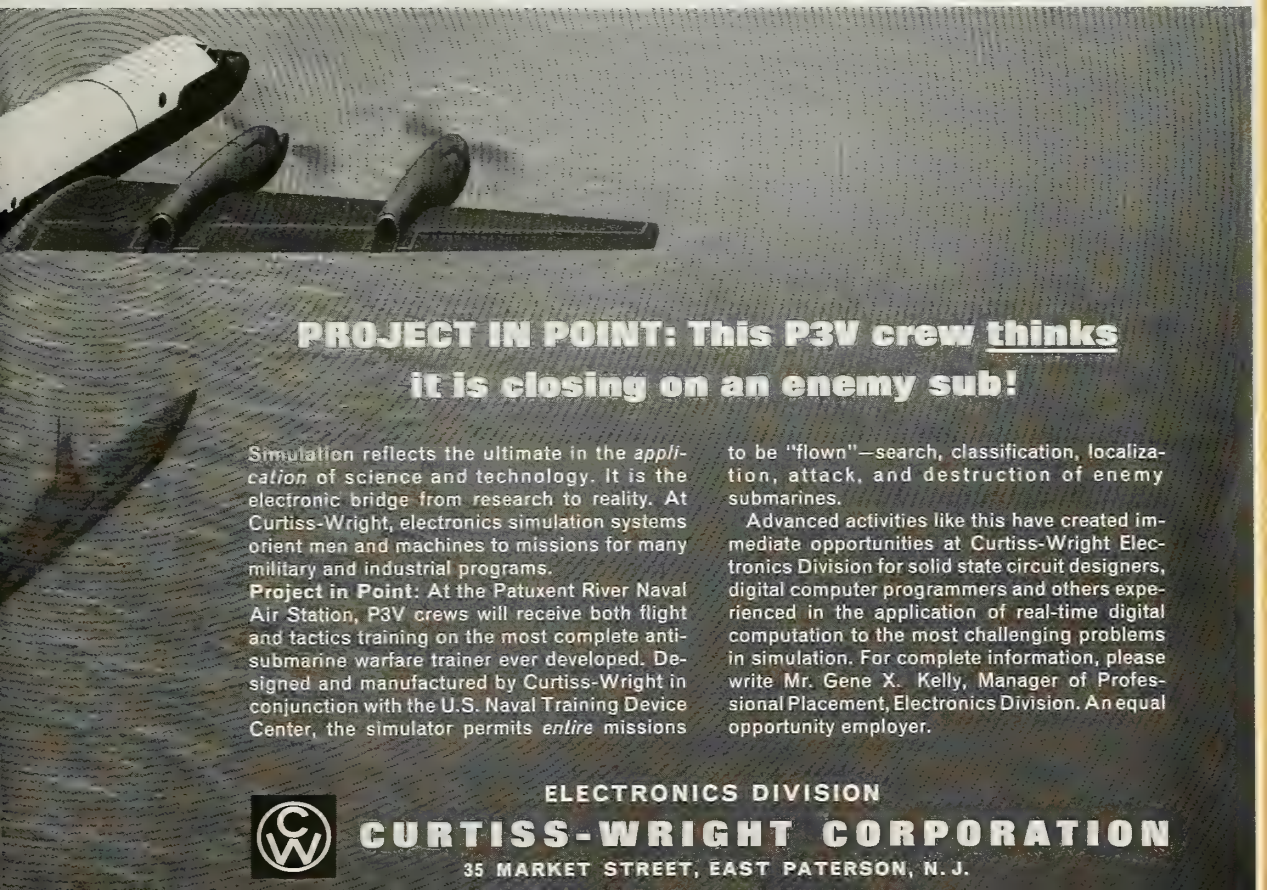
National Aeronautics and Space Administration
Wallops Station
Wallops Island, Va.

Oscilloscope and camera complete with accessories. Lot—IFB P612. Bid opening 1-15-63.

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Directorate—Procurement and Production (SAPOS)
Kelly AFB, Tex.

Note: Select source procurement. Request for proposals has been issued to the following firm: Curtiss-Wright Corp., Wright Aeronautical Div., Wood-Ridge, N.J. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm. P/N 148912 shaft gear—225 each. P/N 896067 studding assembly—4 each. P/N 896040 parts kit—237 each. No drawings or specs are available. Deliver various destinations. Contract AF 41(608)13172. Call 185-SA-N.

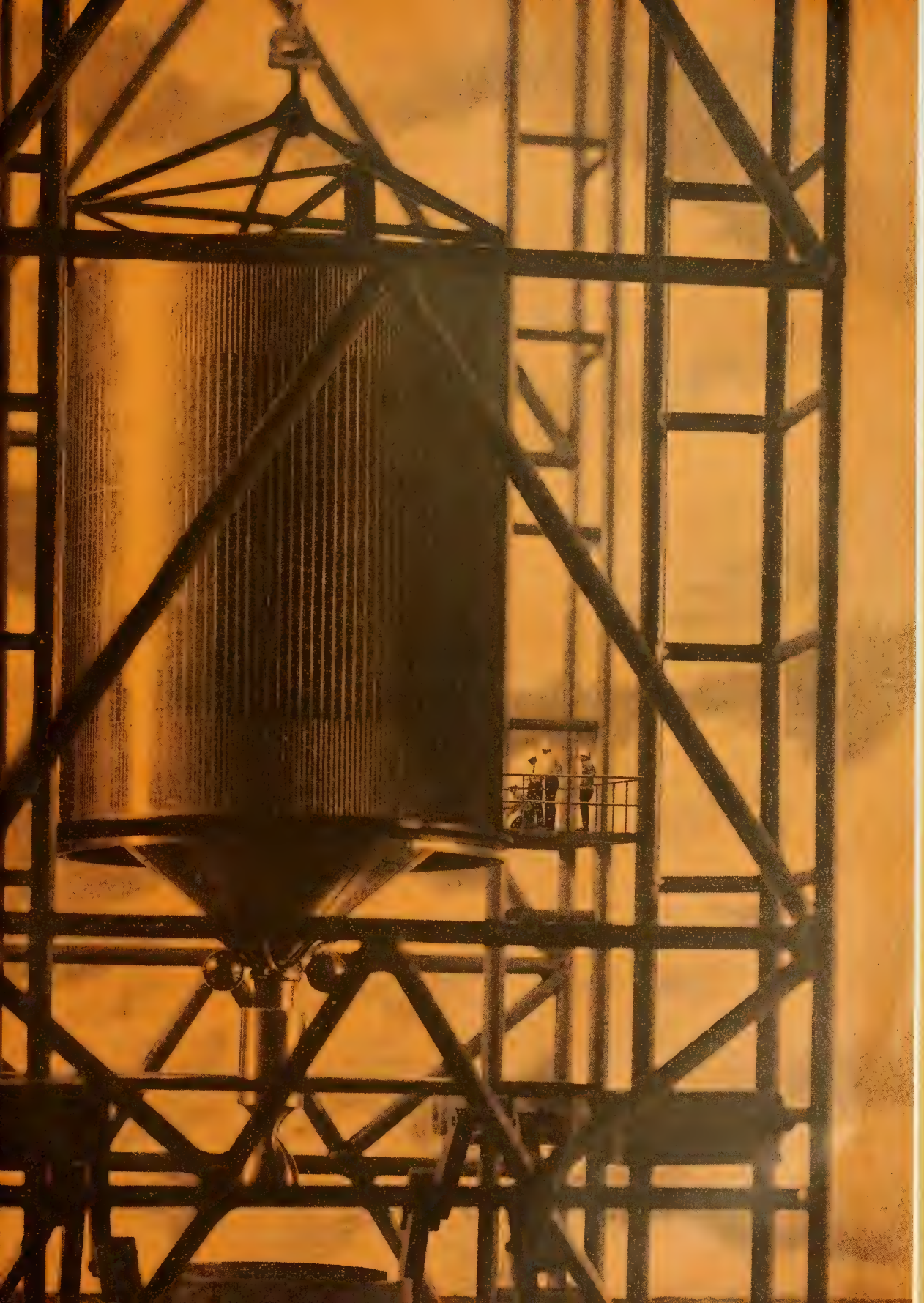
# The giant RIFT vehicle: it will pioneer nuclear-propelled space flight

To propel its space ships through the far reaches of the solar system, the National Aeronautics and Space Administration is studying new kinds of power. NASA feels that nuclear propulsion may be the key to space exploration. It has chosen Lockheed Missiles & Space Company to design and build the nuclear stage of the giant vehicle that will demonstrate the feasibility of nuclear-propelled space flight. As NASA's industrial partner, Lockheed shares the management, scientific, and technical responsibility for the RIFT (Reactor-In-Flight-Test) program. The primary purpose of the RIFT vehicle is R & D. It will help the NASA/Lockheed team develop design data for even more advanced nuclear-stage systems. Yet so great is its promise that Lockheed is designing it for possible use as a stage atop one of tomorrow's mammoth boosters—the 7½-million-pound-thrust Advanced Saturn.

**LOCKHEED MISSILES & SPACE COMPANY** Sunnyvale, California • A Group Division of Lockheed Aircraft Corporation




Photographed in realistic settings, scale models of the RIFT vehicle illustrate (right) how the Lockheed-built nuclear stage will be static-tested at NASA's Nuclear Rocket Development Station, Jackass Flats, Nevada, and (left) how it would look, complete with nose cone, atop the Advanced Saturn booster.

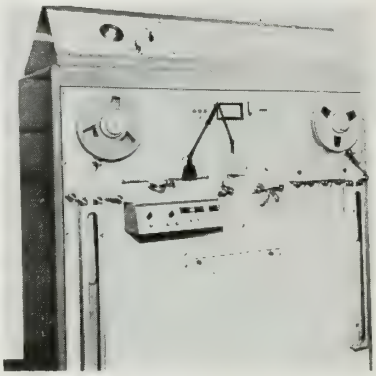


## New Product of the Week:

## Computer Tape Tester

A fully solid-state magnetic tape tester with increased reliability and a 25% reduction in size is available from General Kinetics Inc. Designed to locate dropouts, noise pulses and time-displacement errors in magnetic computer tape, the Model 7-A tester represents an advance over the GKI Standard Model 7 unit.

It employs completely solid-state electronics. The tester has faster stop-start capabilities and improved precision resulting from a new mechanical drive system. The tape drive has been made more gentle by eliminating pinch-rollers. In addition to improved graphic recorders that create a permanent record (in circular graph form) of tape-error regions, the 7-A also includes "nixie" light indicators to provide a total error



count. The model incorporates precision multi-turn potentiometers for setting drop-out and noise-rejection levels.

Circle No. 225 on Subscriber Service Card

### Solid-State Accelerometer

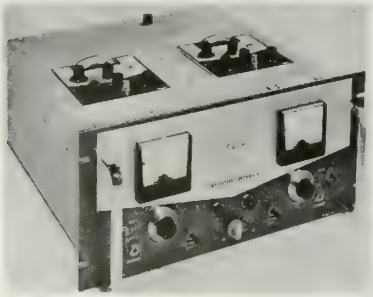
Self-generating accelerometer Model 32, developed by United Aerotronics Corp., contains no wires, jumper strips, or solder. Each unit temperature cycles to stabilize sensitivity. Other features are choice of stick-on or insulated integral stud mounting and spanner-wrench holes provided for deep-hole installation. High 30-millivolt-per-g output coupled with high internal capacitance of 1300 picofarads permits investigation with minimum electronic equipment.

Circle No. 226 on Subscriber Service Card

### Temperature Controller

Developed by Loyola Industries, the Model L-60 infrared temperature controller regulates the temperature of infrared energy sources used as artificial horizons and infrared sources used in testing or deveolping sensing equipment for use with satellite, missile and rocket orientation and detection systems.

Two identical and completely independent infrared temperature-control systems are contained in the Model L-60. Each system is a control loop consisting of a transducer amplifier, a three-mode controller and an SCR power manipulator. Temperature is controlled from 95°F to 220°F with stability of ±1°F. Input of the unit is provided by a resistance temperature sensing element while output to infrared sources is 0-120 volts d-c. A 0 to 100 ua signal provides input to an external recorder for monitoring the infrared energy source's temperature.



Circle No. 227 on Subscriber Service Card

### Thermocouple

Arnoux Corp. offers a high-temperature thermocouple, Model HTT-522, designed to measure temperatures up to 6000°F. Typical applications are measurement of nose-cone re-entry temperatures and pebble-bed heater temperatures, as well as direct measurement of reactor-rod temperatures in atomic powerplant operations.

This nonmetallic, high-output thermocouple can be used—depending on environmental conditions—for extended periods at temperatures to 4200°F, and for shorter periods to 6100°F.

Circle No. 228 on Subscriber Service Card

### Rocket Test System

A portable rocket engine test stand equipped with a small rocket engine and associated controls and instrumentation has been deveolped by Astrosystems International, Inc., for laboratory use. This system, designated Labroc Model V, can simulate operation of large liquid rocket engines employing propellants in current use.

Designed to be used as a research tool, i.e., materials, propellant or plume studies or as an advanced training aid, the system is completely safe and requires no special facilities.

In operation the Labroc Model V simulates the characteristics of current liquid propellant rocket engines in terms of combustion efficiency, flame temperature, Reynolds Number and nozzle temperatures. The console dispalys continuous monitoring of thrust, combustion chamber pressure, fuel flow, oxidizer flow, coolant flow, oxidizer feed pressure, fuel feed pressure, coolant inlet and outlet temperatures.

Circle No. 229 on Subscriber Service Card

### Temperature Control

An uncalibrated explosion-proof temperature control is available from United Electric Controls Co. Type F95 is designed to control temperature of gases, liquids, or hot plates in hazardous locations where explosive vapors or gases are present.

The thermal system consists of a bulb, capillary and bellows filled with temperature-sensitive liquid. The bellows expands or contracts with heating or cooling, actuating a snap-action switch at a preset temperature point. Temperature settings are made by rotating a single hex adjustment.

Circle No. 230 on Subscriber Service Card

### Si-Coated Resistors

A line of silicone-coated precision wire-wound resistors, designated type SA, that meet power requirements in advanced electronic circuitry are available from California Resistor Corp.

Outstanding features include a completely welded terminal-to-terminal construction, low noise and thermal EMF and high stability (less than 0.5% drift in 1000 hours operation at full wattage rating).

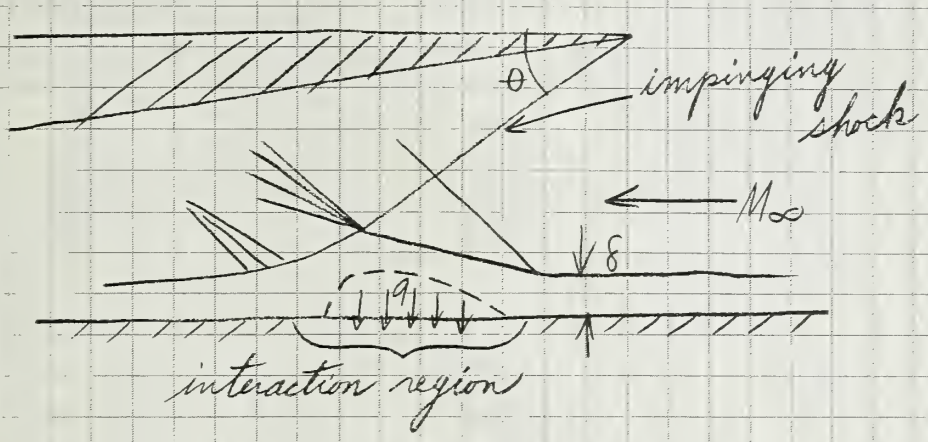
Circle No. 231 on Subscriber Service Card

### Synchro Standards

Astrosystems, Inc. has available Models AM 206S-15 and AM 207S-15 Miniature Precision Synchro Standards. These instruments, despite their compact construction, generate precise, low-impedance servo signals which exactly simulate precision synchros at every one of the 24 angular settings provided.

Circle No. 232 on Subscriber Service Card

*Of interest to engineers and scientists*




# AERO-THERMODYNAMICS

*...among the more than 500 R & D programs under way at Douglas*

Extensive research in advanced aero-thermodynamics relating to missiles and space vehicles is now being performed in Douglas laboratories.

Among current areas are dissociation nonequilibrium in supersonic flows; separated supersonic boundary layer phenomena; experimental boundary layer studies; heat transfer; turbulent mass transfer; and base flow.

Support of this program is provided through a multi-million dollar laboratory complex. Included is the Douglas Aerophysics Laboratory, one of the finest fluid dynamic research facilities in the aerospace industry.

**Of career interest to engineers and scientists**

If you are seeking stimulating assignments and associates, full support of your activities, and an open door to advancement, investigate the outstanding career opportunities at Douglas.

Here, the emphasis is on the research and development that solve today's problems and lead to involvement in the biggest defense and space projects of tomorrow. Also, scholarships and financial assistance are available to continue your studies in such nearby universities as U.C.L.A., Southern California and Cal Tech.

Send us your resume or fill out and mail the coupon. Within 15 days from the receipt of your letter, we will send you specific information on opportunities in your field at Douglas.

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Engineering or scientific field_____

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UTC

## United Technology Center

P. O. BOX 358, SUNNYVALE, CALIFORNIA
*(Formerly United Technology Corporation)*

DIVISION OF UNITED AIRCRAFT CORPORATION

Circle No. 12 on Subscriber Service Card

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# when and where

### DECEMBER

**Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science,** Philadelphia, Dec. 26-31.

**American Astronautical Society Symposium on Scientific Satellites—Mission and Design,** Franklin Hall, Philadelphia, Dec. 27.

### JANUARY

**Millimeter and Submillimeter Conference, IRE,** Cherry Plaza Hotel, Orlando, Fla., Jan. 7-10.

**American Chemical Society National Meeting,** Cincinnati, Jan. 13-18.

**Automotive Engineering Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Jan. 14-18.

**Ninth Annual American Astronautical Society Meeting,** Statler Hilton Hotel, Los Angeles, Jan. 15-17.

**31st Annual Meeting, Institute of the Aerospace Sciences,** Hotel Astor, New York City, Jan. 21-23.

**43rd Annual Meeting, American Meteorological Society,** New York City, Jan. 21-24.

**Ninth National Symposium on Reliability and Quality Control,** Sheraton-Palace Hotel, San Francisco, Jan. 22-24.

**Fifth Annual Army Aviation Contract Services Symposium, sponsored by National Aeronautical Services Assn.,** International Inn, Washington, D. C., Jan. 28.

**Fourth Annual Solid Propellant Rocket Conference, American Rocket Society,** Bellevue Stratford Hotel and the Franklin Institute, Philadelphia, Jan. 30-Feb. 1.

### FEBRUARY

**Symposium on Engineering for Major Scientific Programs,** Georgia Institute of Technology, Atlanta, Feb. 5-6.

**Electronic Sales-Marketing Assn., First Annual Convention,** Americana Hotel, New York City, Feb. 11-13.

**Third International Symposium on Quantum Electronics, sponsored by International Scientific Radio Union, Office of Naval Research and La Federation Nationale des Industries Electroniques,** UNESCO Building, Paris, Feb. 11-15.

**Space Vehicle Thermal and Atmosphere Control Symposium, sponsored by Aeronautical Systems Div.'s Flight Accessories Laboratory,** Engineers Club, Dayton, Ohio, Feb. 12-13.

**1963 International Solid State Circuits Conference, sponsored by IRE, AIEE and University of Pennsylvania,** Philadelphia, Feb. 20-22.

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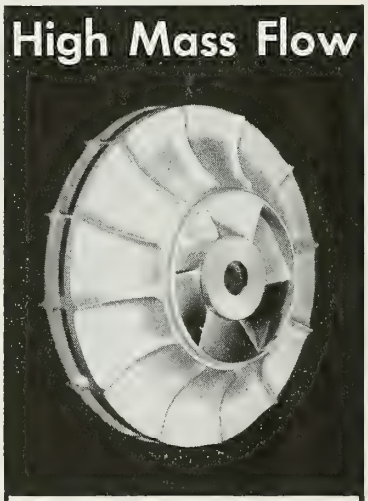
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# Letter From the Editor

WITH THIS last issue of December, it is once again time to look back in our annual survey of the industry's accomplishments during the year. The list is impressive.

At the same time, a glance ahead at 1963 leads to a forecast that while the coming year will perhaps be less exciting for the industry, it will be one in which considerable progress will be made in a more mundane fashion.

The thrilling payoffs of 1962 in scientific and technical advances in space will not really be repeated again until 1964. The new year will be one in which many of the accomplishments of the past year will be digested and the foundations laid for further steps forward.

It will be a year of solid progress. But it will not be a year to match the swift strides and exciting successes of 1962. A baby's first steps always are those most warmly remembered.

This was the year in which three Americans made their first orbital flights around the Earth. Lt. Col. John H. Glenn of the U.S. Marine Corps was the first, while an entire nation watched on television with throat-clutching fear and pride. He was followed in his three-orbit flight by the Navy's Commander Scott Carpenter and by Commander Walter Schirra, who made the first six-orbit trip.

This also was the year in which the team for the *Apollo* manned lunar flight firmed up its direction and began the long task of sending a U.S. expedition to the Moon and back later in this decade. The decision was made to employ lunar orbit rendezvous in the attempt. To one of the nation's finest builders of aircraft, Grumman Aircraft Engineering Corp., went the award for the Lunar Excursion Module which will land the first Americans on the Moon. For *Apollo,* the glory lies in the future but the hard work got under way this year.

For the first time in the history of man, Earth reached out during 1962 and probed the surface of one of its planetary neighbors. The *Mariner II* fly-by of Venus was a space accomplishment which reflected great credit on all those associated with the program. Even now, the data are being analyzed which will give us the first elementary information on the cloud-shrouded planet. The sheer magnitude of the *Mariner* accomplishment is hard to grasp, for it has opened a door which never again will be closed. The gain in actual information will be minute in comparison with future strides, but it is a scientific "first" which will long be remembered.

Then there was *Telstar.* Here again was a space achievement which caught the imagination of the entire nation. It also offered the first practical demonstration of the use of satellites for commercial purposes. Transatlantic transmission of television, telephone conversations and data by commercial satellite were proven out. The private enterprise experimental satellite was the first step toward the immense military and commercial communications systems which will orbit the Earth in years ahead.

*Telstar's* government cousin, *Relay,* also was placed in near-perfect orbit, but equipment breakdown brought initially disappointing results.

Nor was all well in other areas of the nation's missile/space programs. Efforts to probe the Moon resulted in five straight failures in the *Ranger* program, although lunar impact was accomplished. *Ranger* has been given the go-ahead sign by a special investigating committee and will try again in 1963. The delay-plagued *Centaur* program continued to limp along this year. Whether its management transfer to Lewis Research Center will cure its ills remains to be seen. But the *Centaur* troubles—if not solved—will affect seriously the U.S. space program in the years ahead.

*Advent,* ill-starred Army-managed effort at a triservice military communications satellite system, came to the end of the trail during 1962. The program was wiped out, to hearty cheers from the Air Force, and is to be replaced by a better-oriented program.

IN THE MISSILE FIELD, both *Skybolt* and *Polaris A-3* were ending the year on a gloomy note. *Skybolt's* troubles were technical, budgetary and political.

The troubles of the A-3 *Polaris,* according to its technicians, were random. The past record of this program is such that 1963 most likely will see its difficulties solved and schedules met.

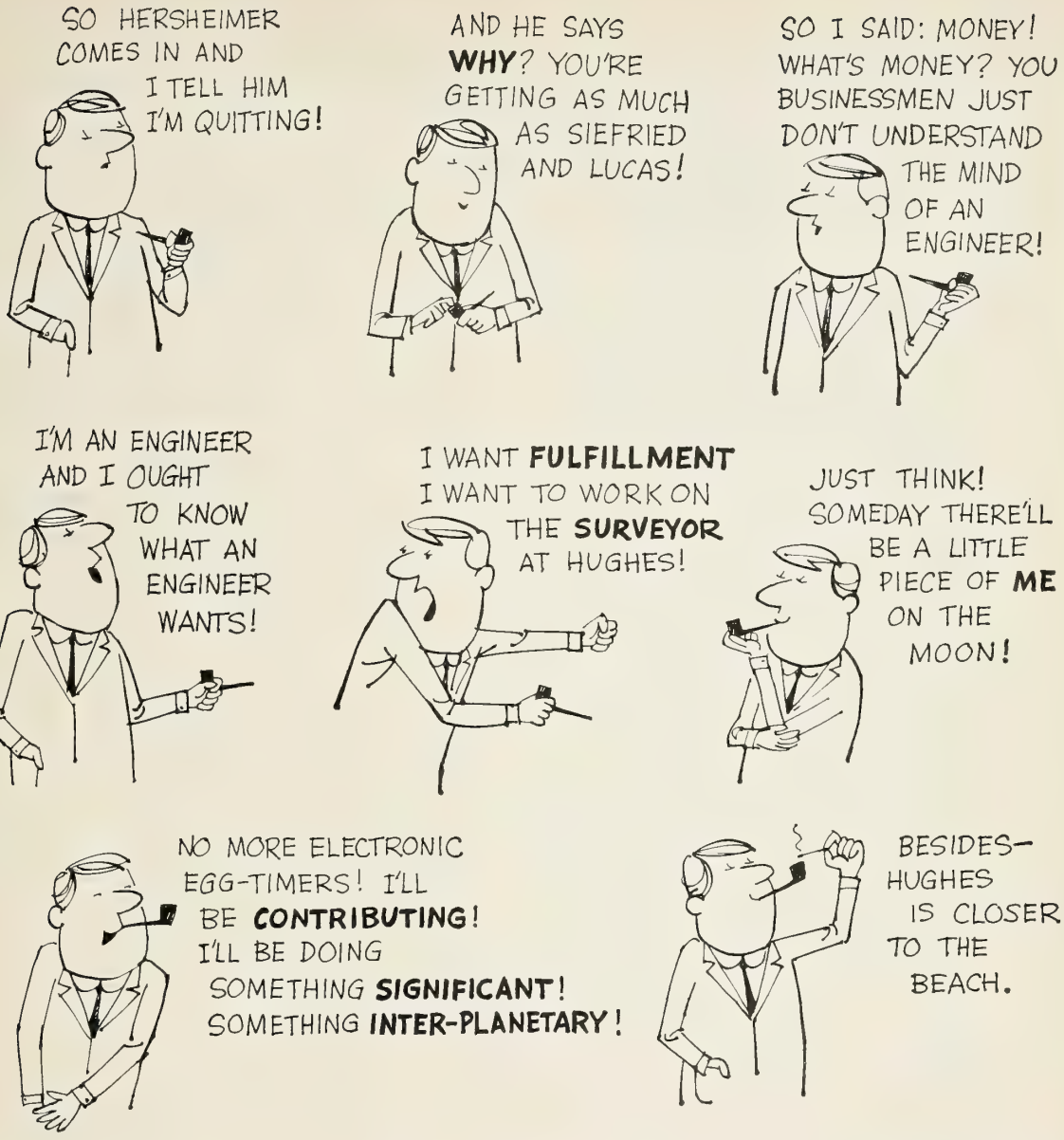
But the missiles that gave the most trouble during the year and provided some of its most exciting moments were not even U.S.-made. They were Russian *T-4's* and *T-5A's* planted on Cuban soil by the Soviet Union. Their threat, before removal, served again as a reminder of the deadliness of the products of this industry.

Nor were Soviet accomplishments during the year limited to shipping missiles and aircraft back and forth across the Atlantic. The most spectacular manned space achievement to date came with the twin flights of Soviet cosmonauts Nikolayev and Popovich, a near-rendezvous in space which will not be matched by the U.S. in the year ahead. There also is a Russian probe enroute to Mars as the year ends.

Meanwhile, the record of the giant *Saturn* booster, with three successful launches at Cape Canaveral, offers hope of swift U.S. strides in pursuit of the Russians in this decade.

ALL IN ALL, an intense, exciting year which we close with the traditional greeting from all of us on MISSILES AND ROCKETS to all of you. A very Merry Christmas and a peaceful, Happy New Year.

**William J. Coughlin**




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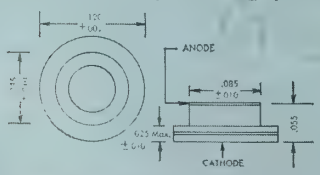
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